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Microwave Instrument Update

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AIRS Science Team Meeting; Greenbelt, MD; November 30, 2004

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Topics

- **Instrument status**
- **Changes for V4**
- **Scan bias analysis**
- **Plans for V5**

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Microwave Instrument Status

- **AMSU-A**
  - ***Two channels have experienced slowly declining gain***
  - ***Recently many -A2 temperature sensors became very noisy***

- **HSB**
  - ***Still not working***
    - The plan is to put in place a procedure to try periodic re-starts
    - Procedure expected to be in place early next year
    - Last “kick-start” attempt was on January 16, 2004

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AMSU Gain Variation: Ch. 4-6

(More in backup slides)

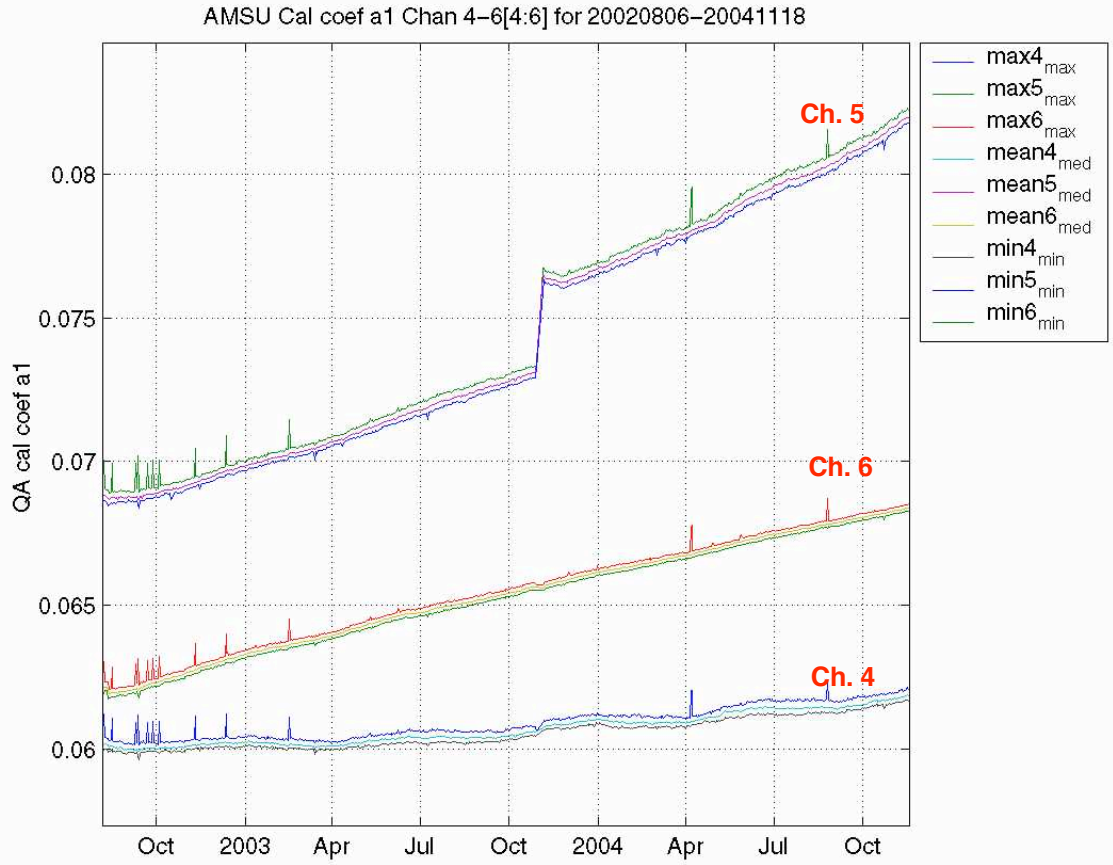
Shown: calibration coefficient $a_1 \approx 1/\text{gain}$

Channel 4 shows negligible gain change

Channel 5 shows 8%/year gain decline

Channel 5 also showed 5% drop after solar flare

Channel 6 shows 4%/year gain decline



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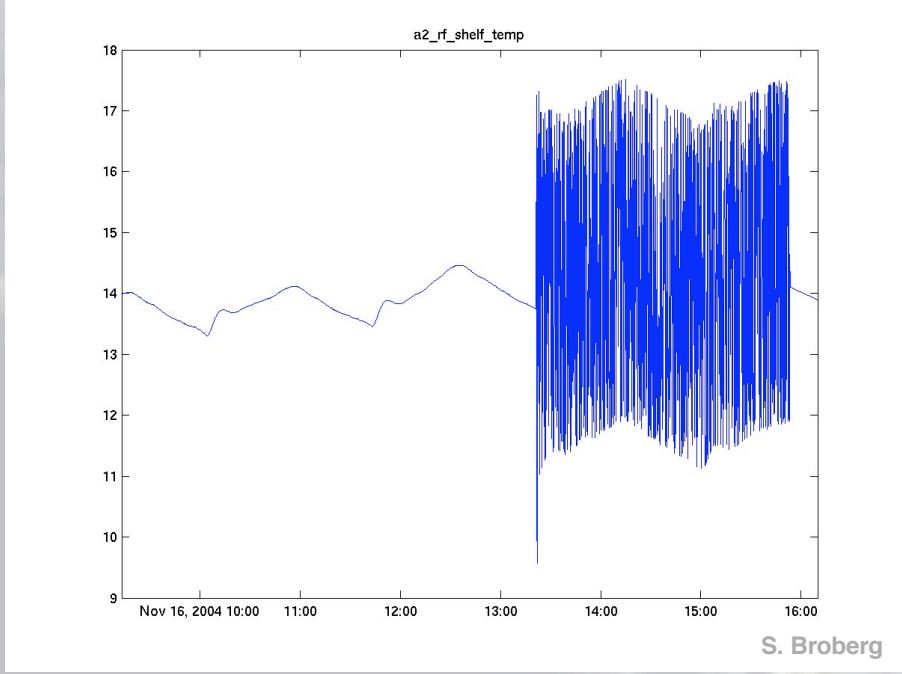
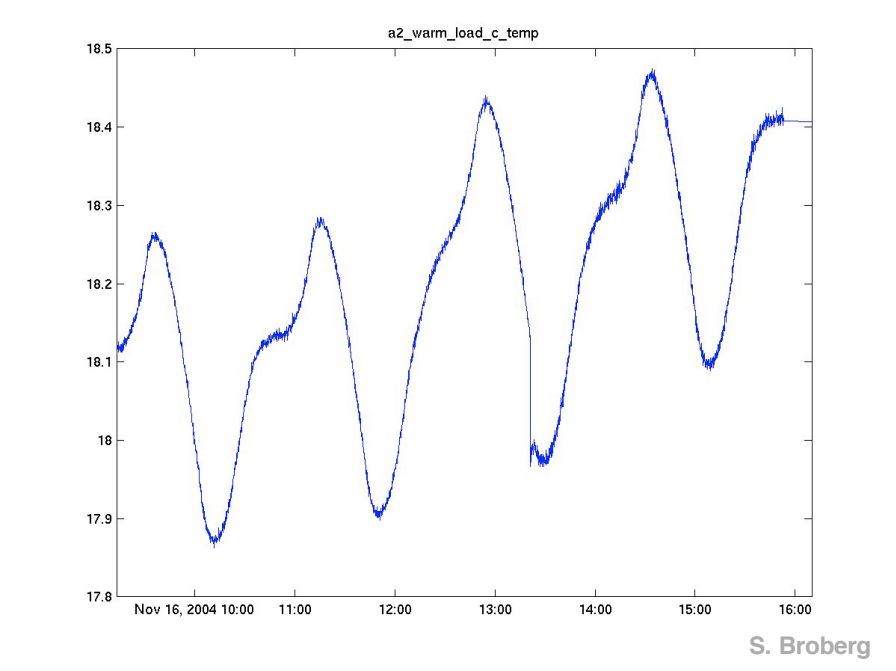
AMSU-A2 Anomalous Temperatures





All instrument-PRT readings became very noisy on November 16 (Also "PRT Ref Voltage")
All warm load readings are still good

This is currently under investigation at JPL and NGES

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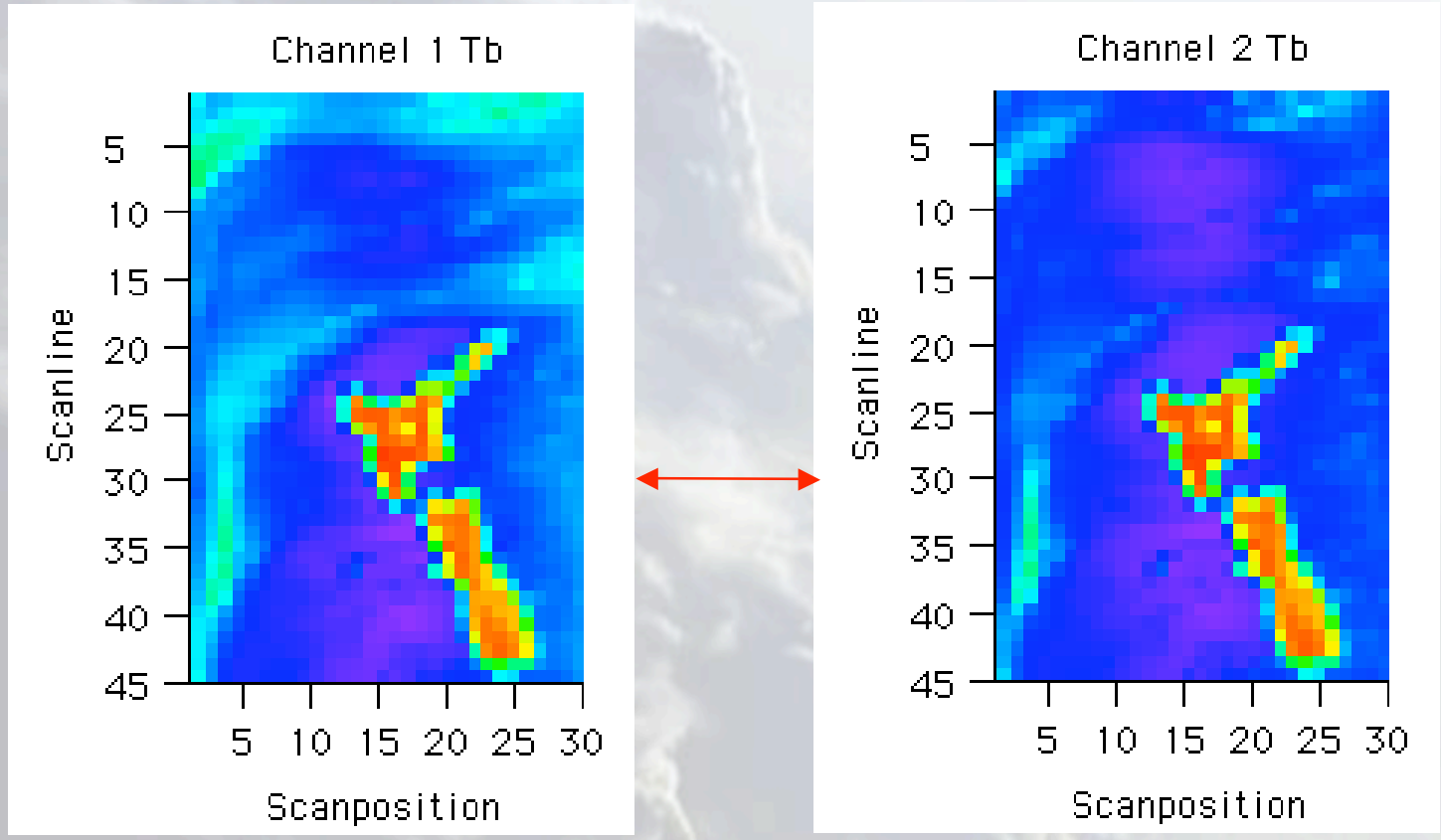
No Anomalous Brightness Temperatures



Start of anomaly is not discernible

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Preliminary Anomaly Assessment

- **No effect on calibration or Tb's can be discerned**
- **This is expected:**
  - ***Only "RF shelf T" is used besides the warm load T's***
  - ***It is used to interpolate lookup tables***
    - Warm load correction
    - Nonlinearity correction
  - ***Both corrections are very small***
    - A 3 K T-error translates into << 1 K
- **Nevertheless, we may put in place a quick fix:**
  - ***Either smooth RF-shelf-T***
    - Downside: requires a very wide window (many granules)
  - ***Or find a substitute T***
    - Looking at "RF-shelf-T" ≈ a + b • Warm-load-T (by regression)
  - ***Or use Passive-Analog instrument-T***
    - Downside: Sampled only every 8th scan line

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Microwave L1b Changes in V4

- **Only minor changes**
  - ***Two Tb slots (implemented in V3.5)***
    - Antenna temperatures (Ta): radiometrically calibrated Tb's
    - Brightness temperatures (Tb): scan bias corrected Ta
    - Tb is currently identical to Ta (awaiting bias correction)
  - ***Narrower window for "moon-in-FOV" flag***
  - ***Fix for data gaps when moon appears in cold-cal FOV***
    - All cold-cal looks affected when moon is in FOV
    - Therefore: cannot compute calibration coefficients
    - Normally: use last valid coefficients
    - But: coefficients do not get carried across granule boundaries
    - Moon-in-FOV can last for up to ~2 granules
    - This has caused data gaps for prolonged moon encounters
    - Fix: bridge across granule boundaries

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AMSU Scan Bias Analysis Using AIRS

- **Objective is definitive scan bias characterization**
  - ***Identify best "truth" for "obs-sim"***
  - ***Determine empirical relative scan bias and absolute nadir bias***
  - ***Compare with modeled scan bias***
  - ***Compare with AIRS***

- **All analysis shown is for clear/ocean/±30°/Sep.6'02**

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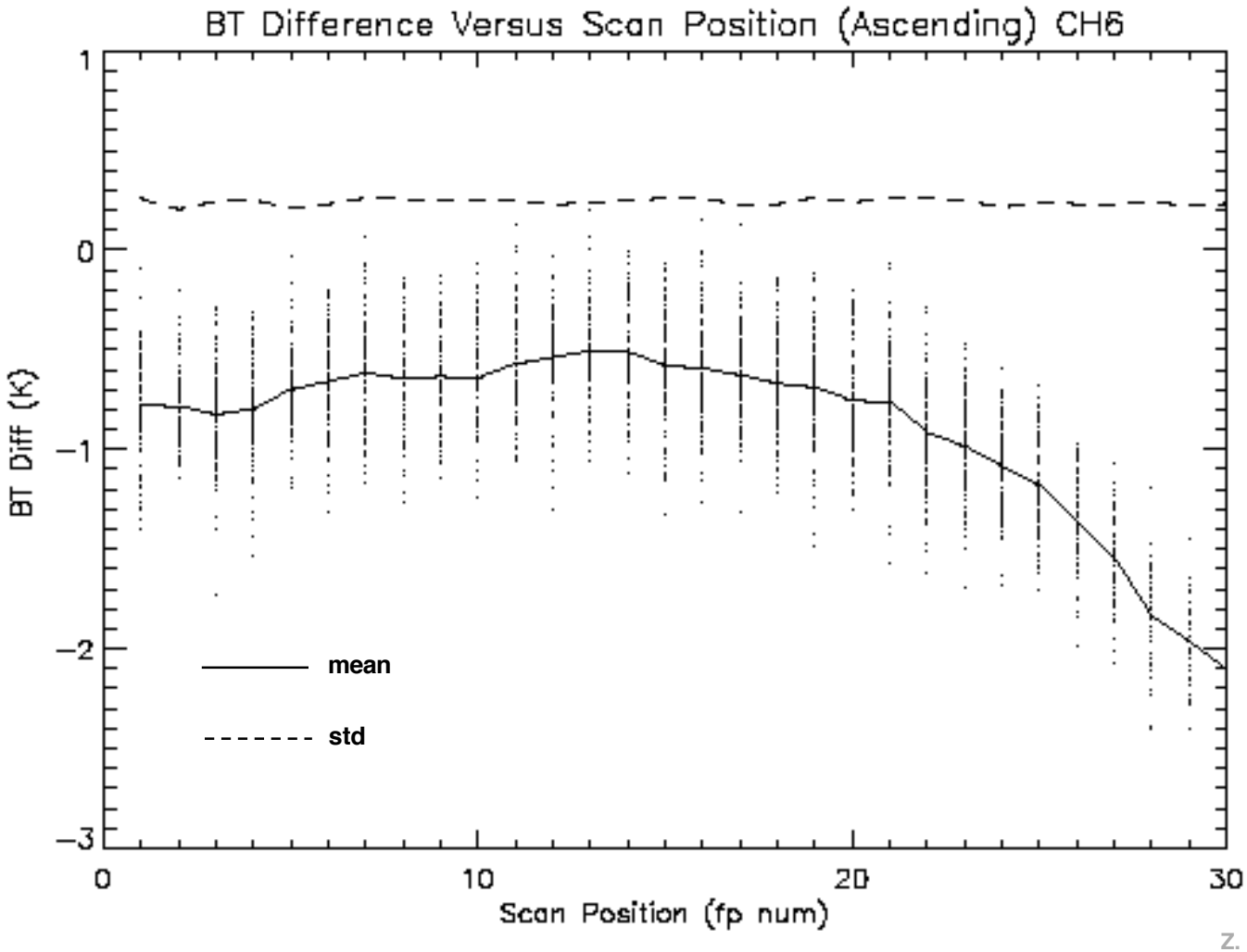
Scan Bias Example: Channel 6



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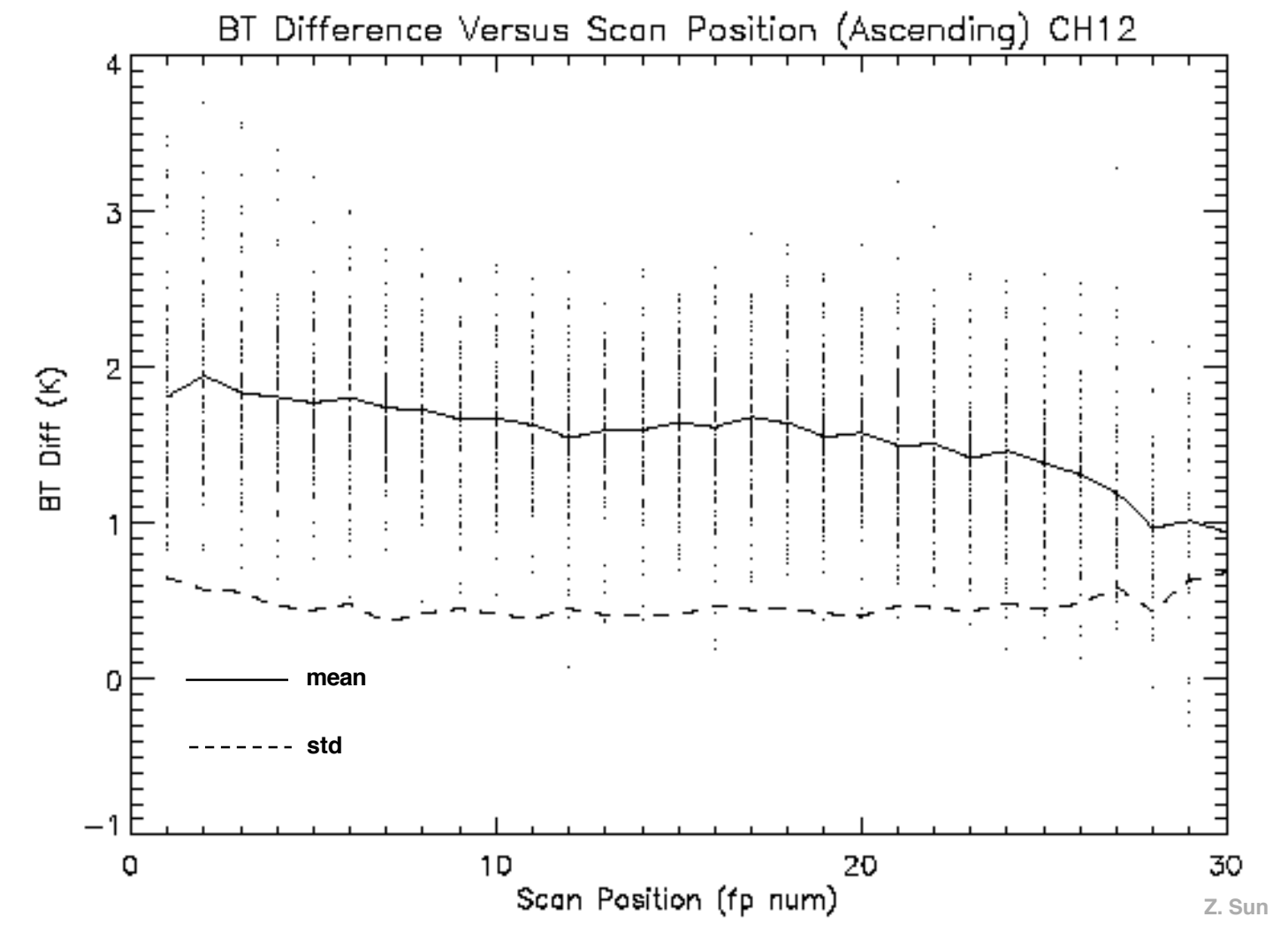
Scan Bias Example: Channel 12



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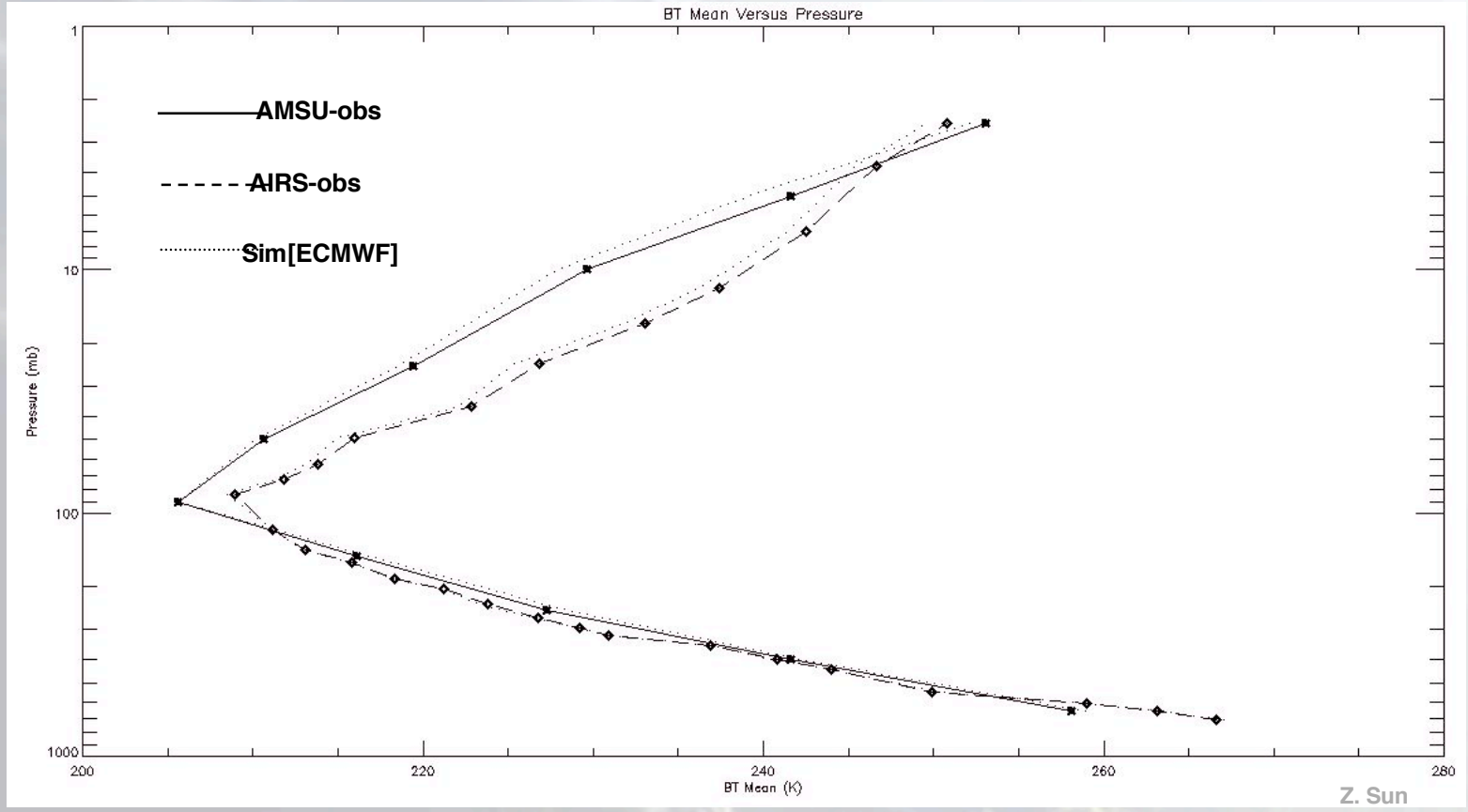
Equivalent AIRS Channels



Tb at peak of weighting function - Weighting functions for standard atmosphere

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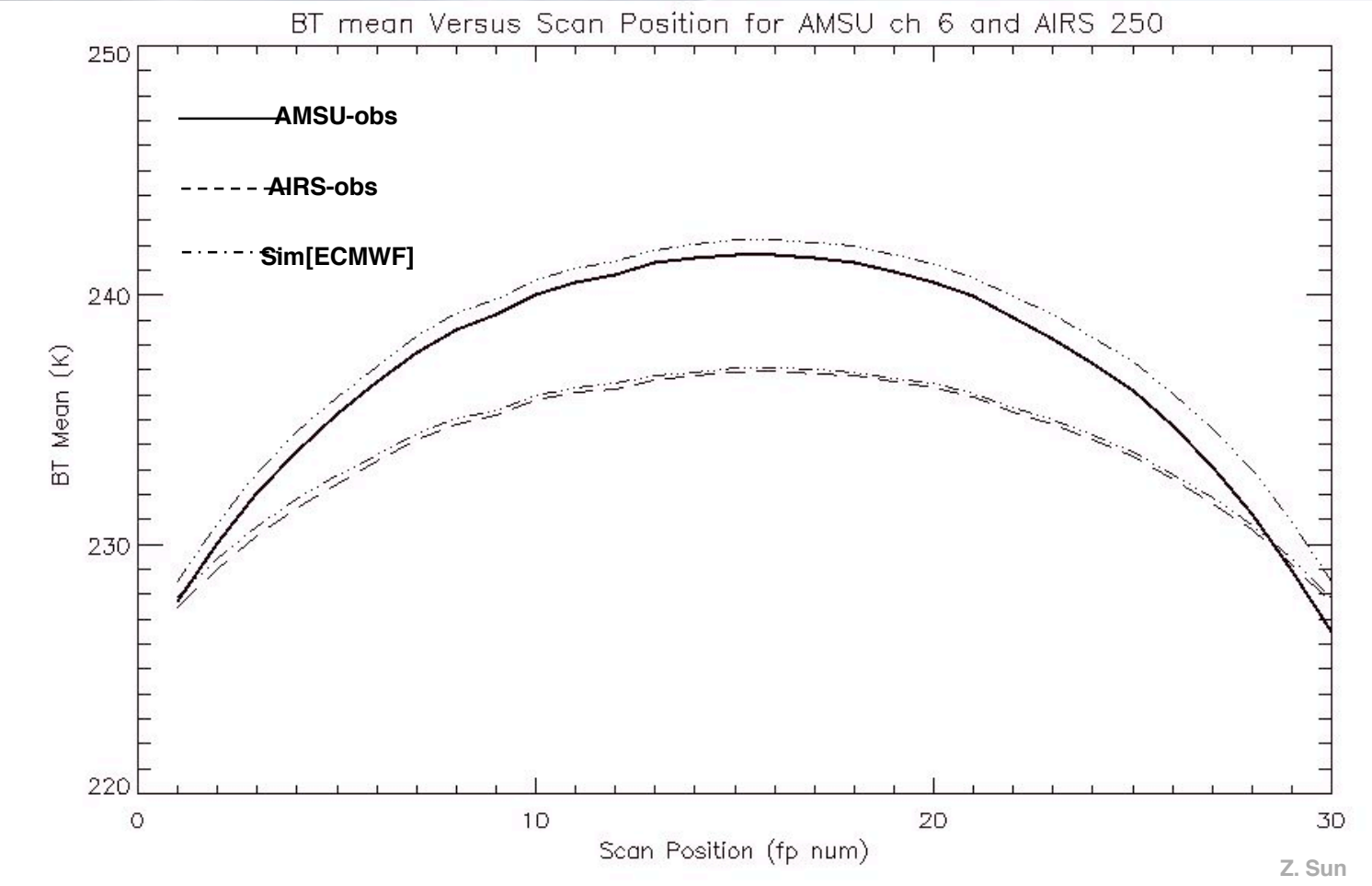
AMSU & AIRS obs & sim vs. scan: Ch. 6



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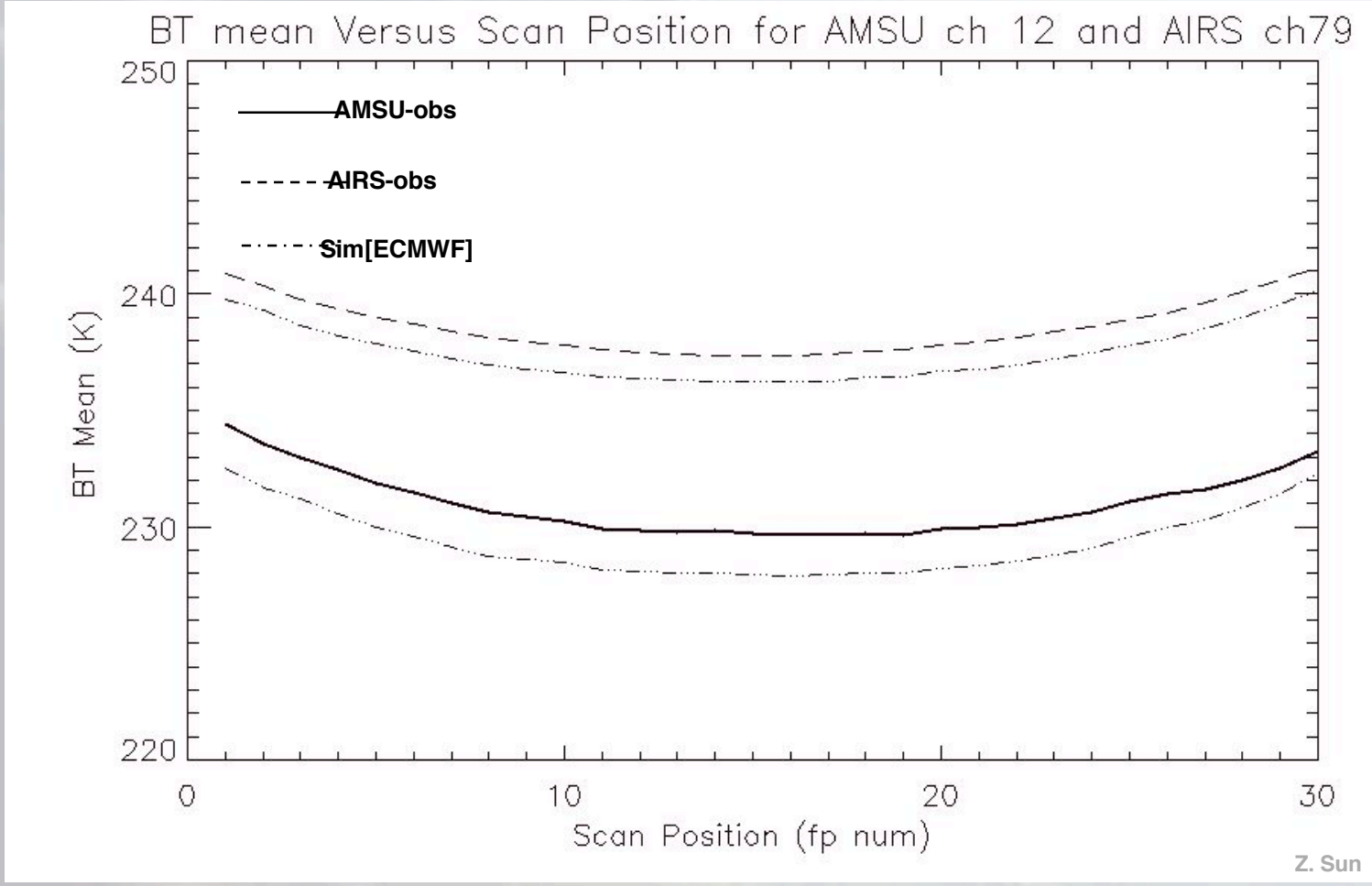
AMSU & AIRS obs & sim vs. scan: Ch. 12

(More in backup slides)



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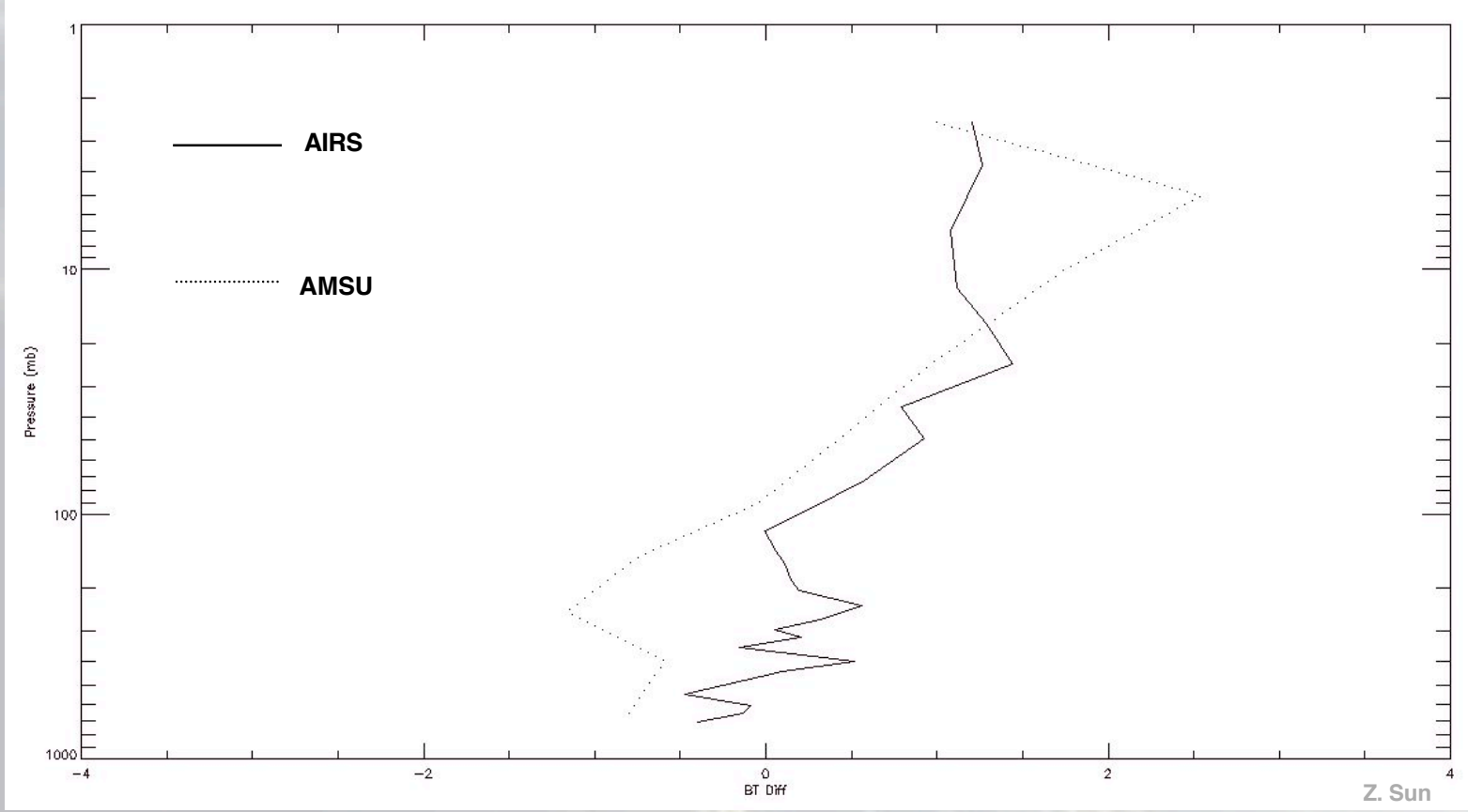
AMSU & AIRS obs-calc summary: Nadir



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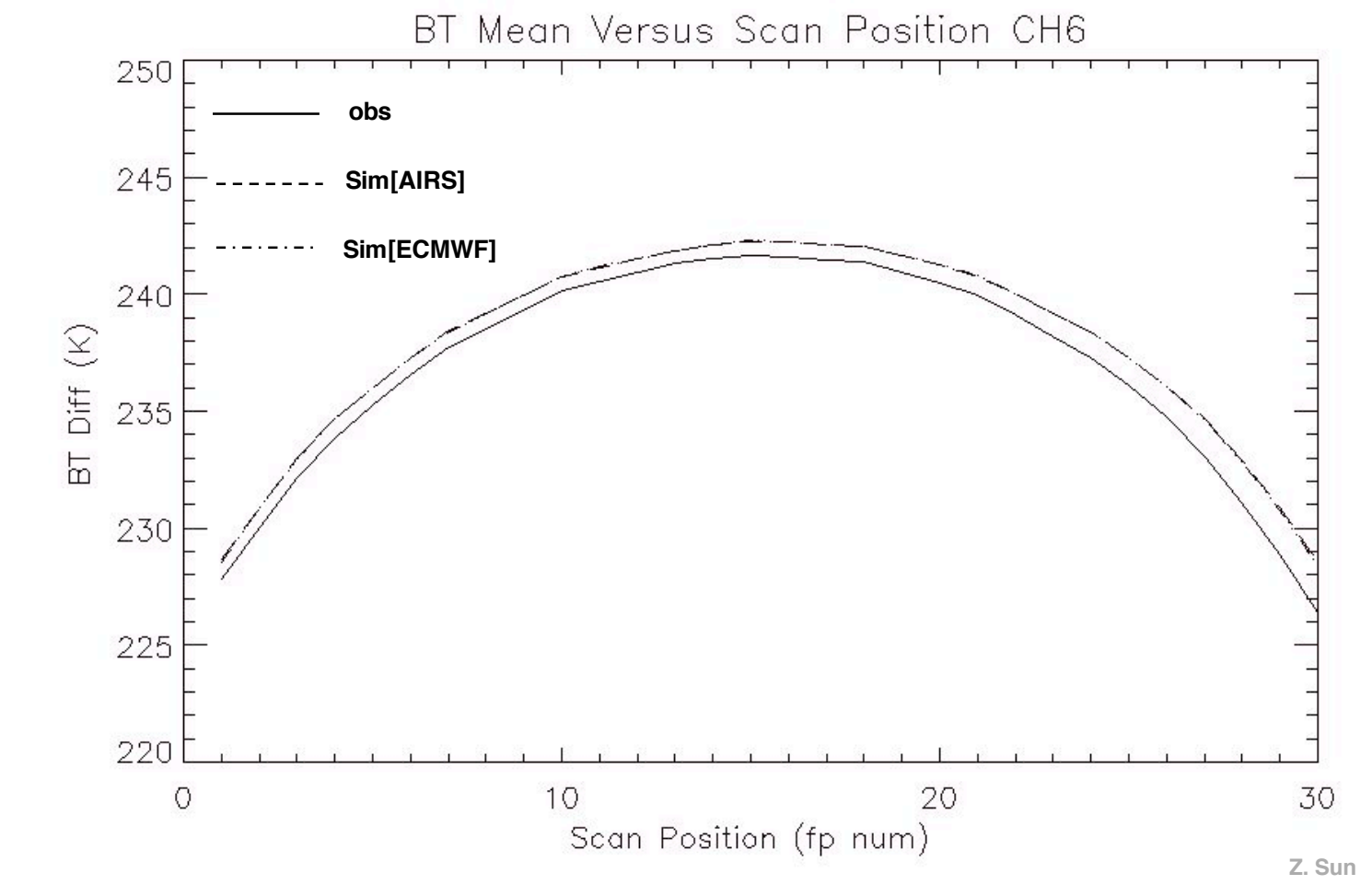
Sim[ECMWF] vs. Sim[AIRS]: Ch. 6



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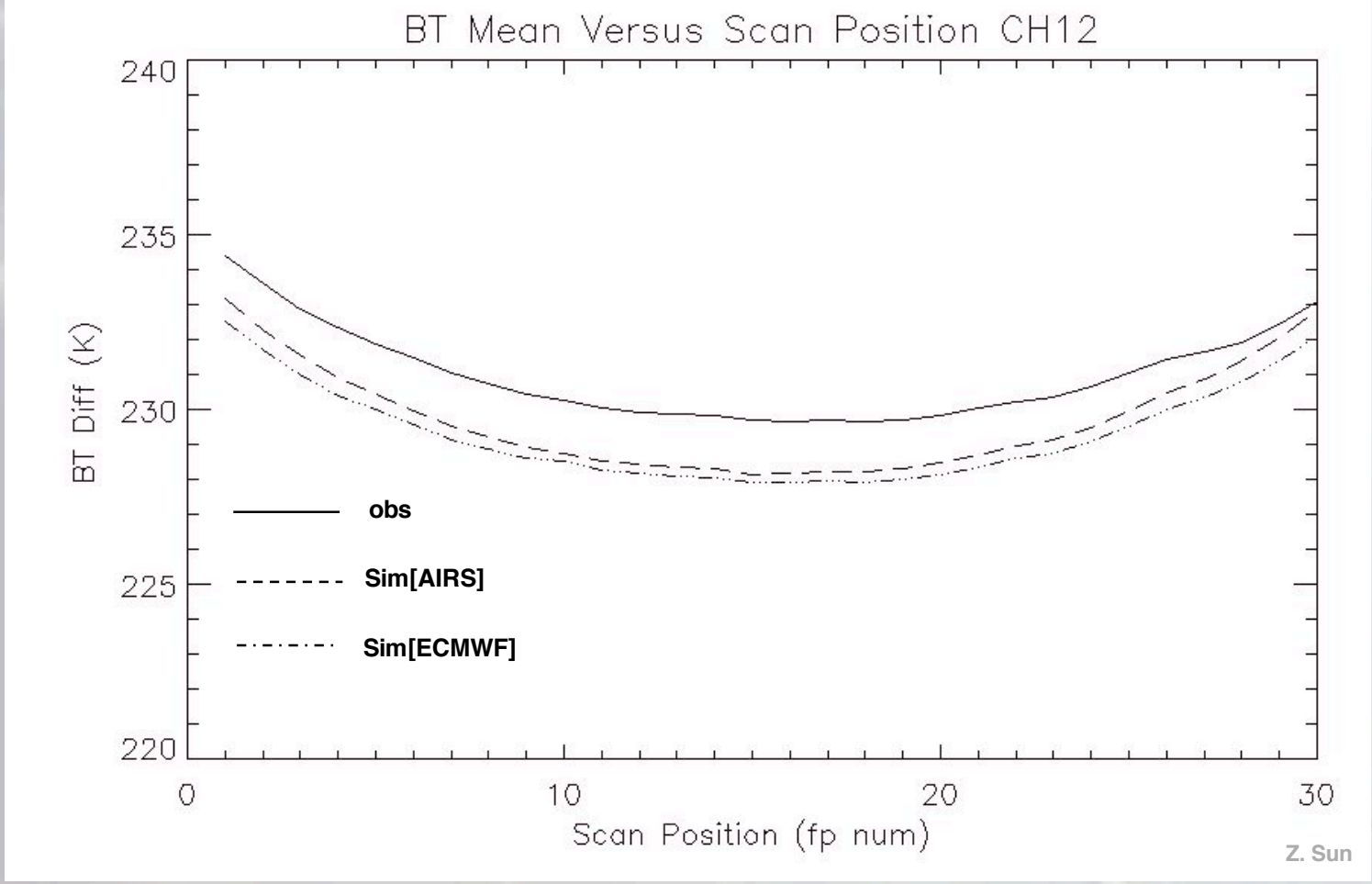
Sim[ECMWF] vs. Sim[AIRS]: Ch. 12

(More in backup slides)



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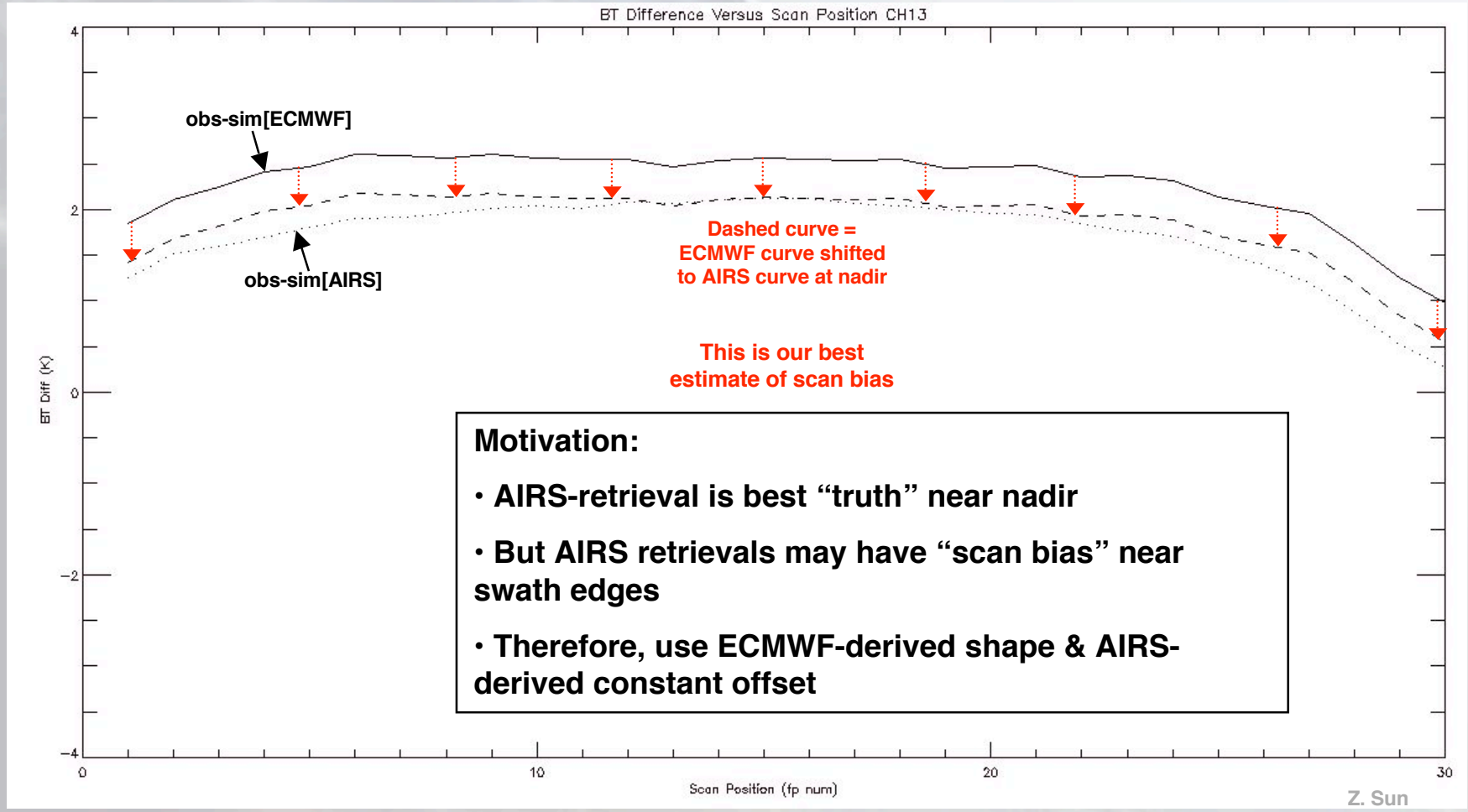
obs-sim[AIRS] vs. obs-sim[ECMWF]

(More in backup slides)

Channel 13



Motivation:

- **AIRS-retrieval is best "truth" near nadir**
- **But AIRS retrievals may have "scan bias" near swath edges**
- **Therefore, use ECMWF-derived shape & AIRS-derived constant offset**

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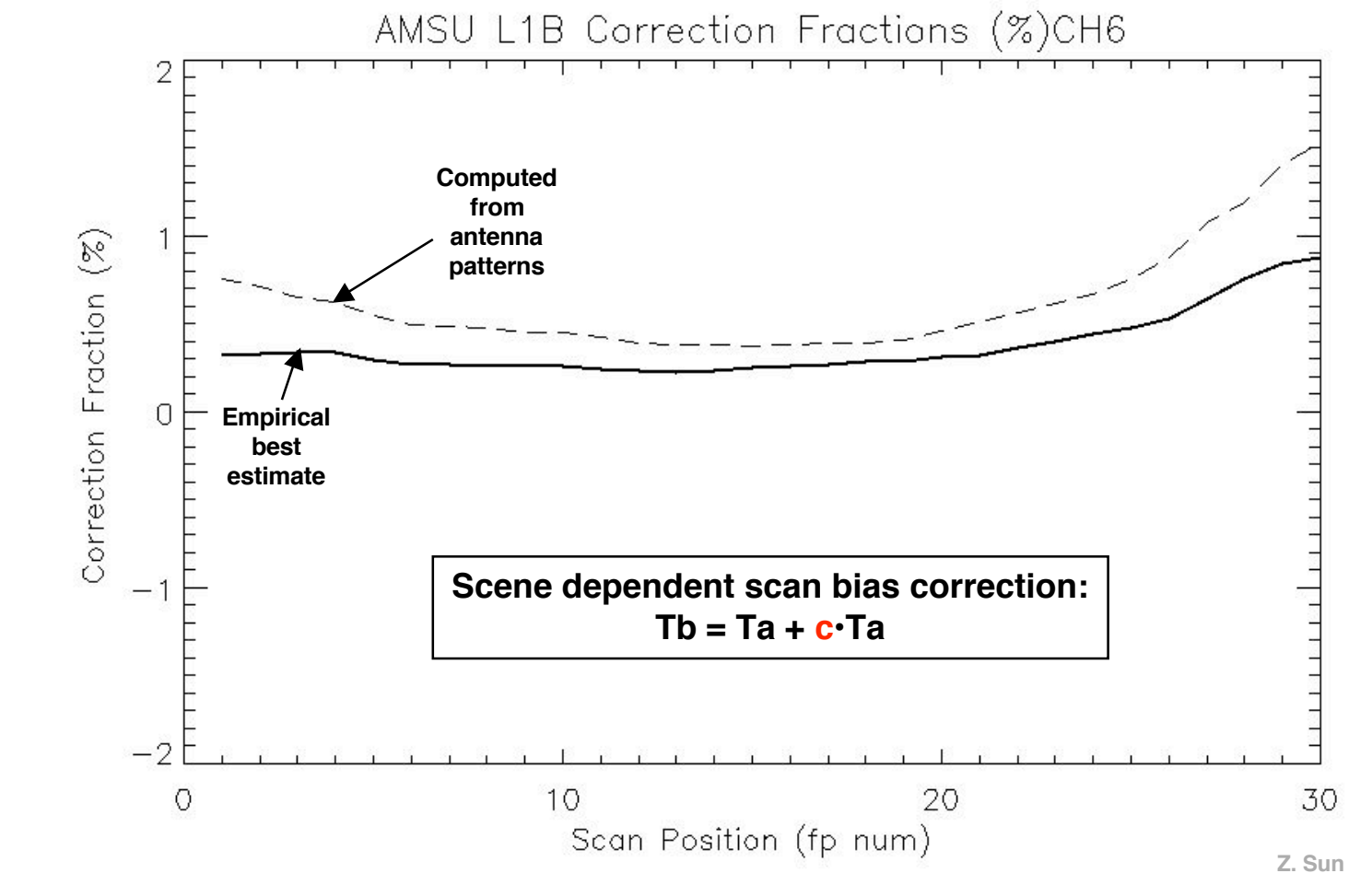
Scan Bias Correction Coefficients

(More in backup slides)

Channel 6



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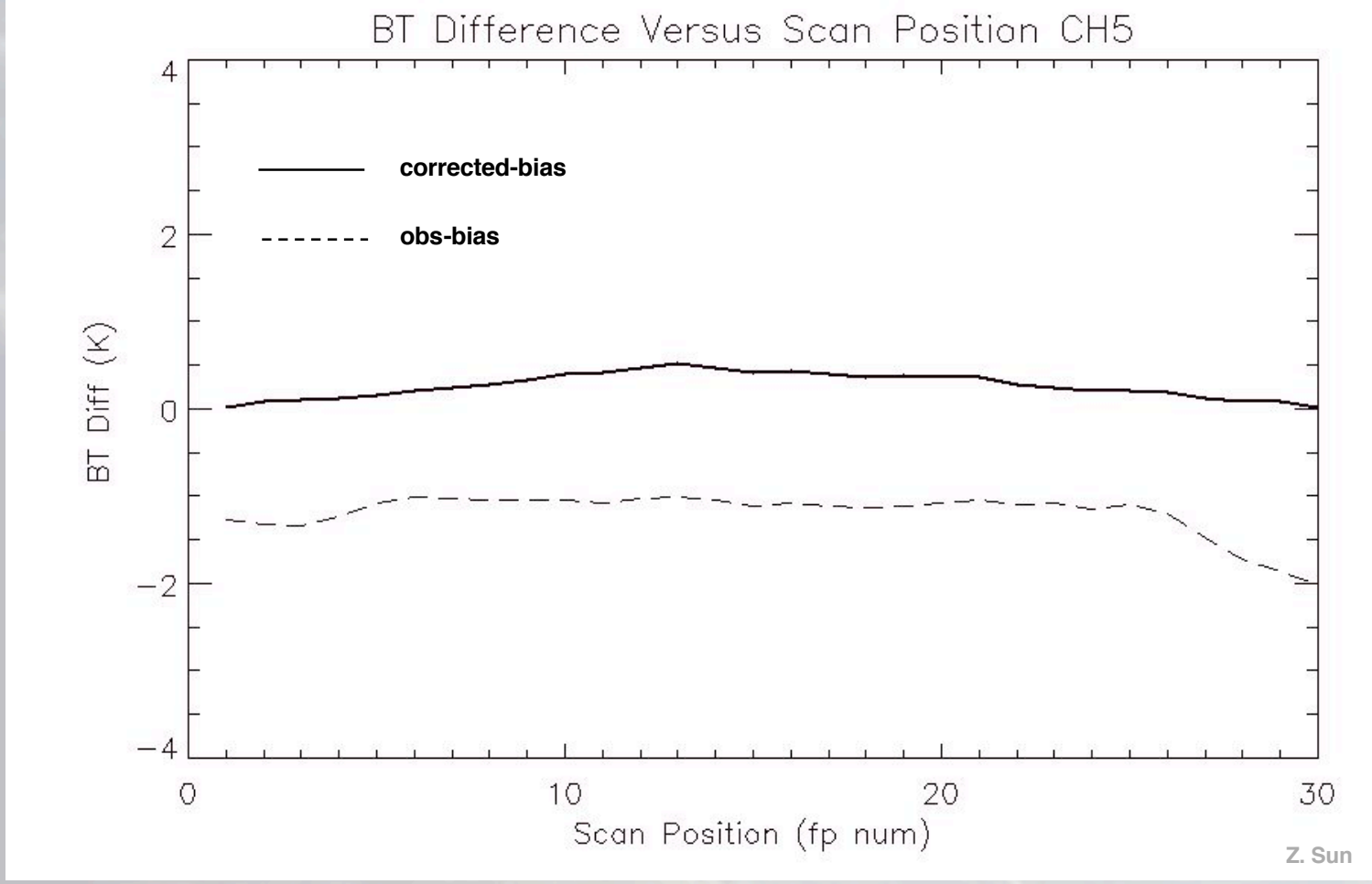
Empirical Scan Bias Correction: Ch. 5



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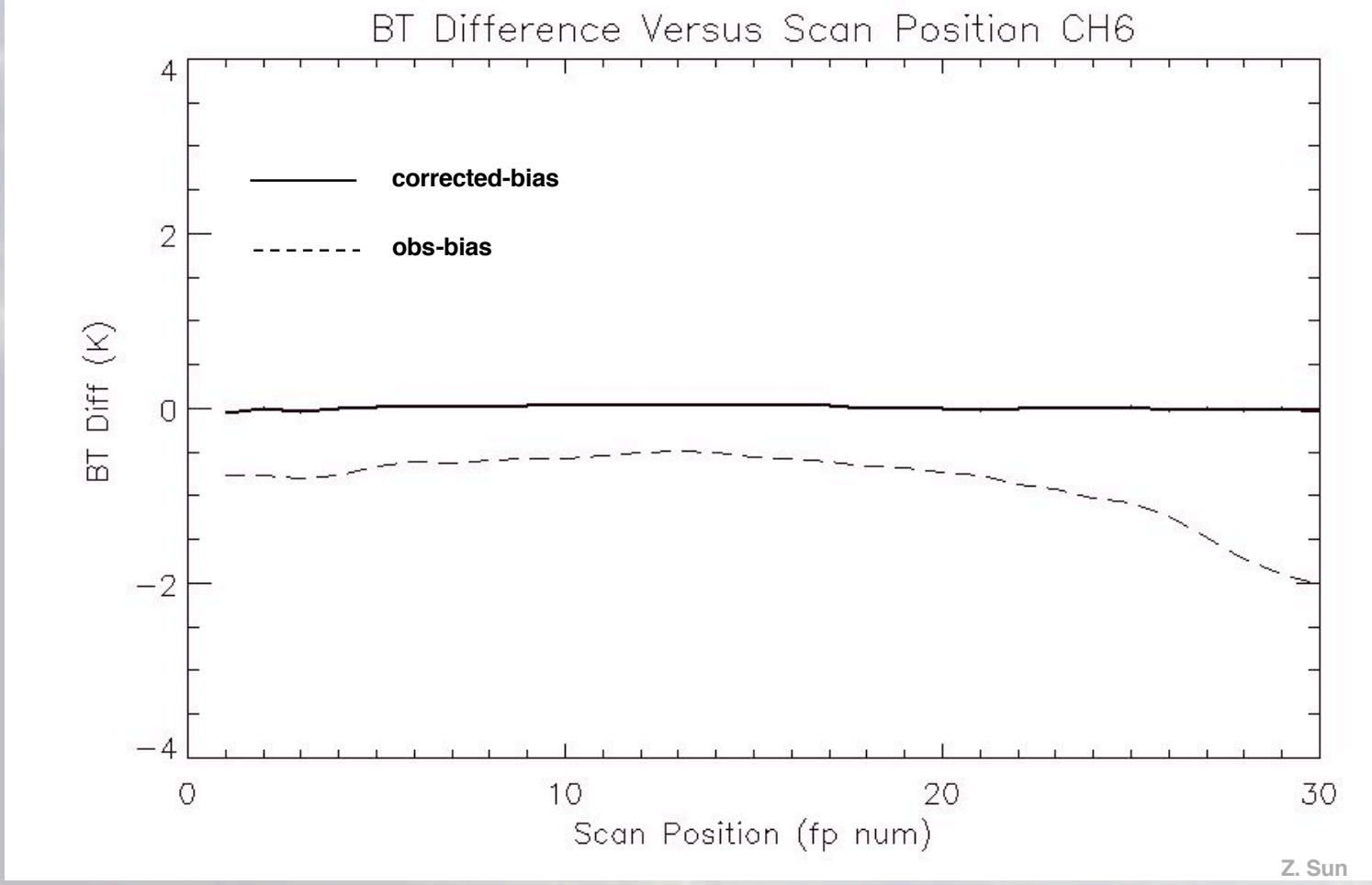
Empirical Scan Bias Correction: Ch. 6



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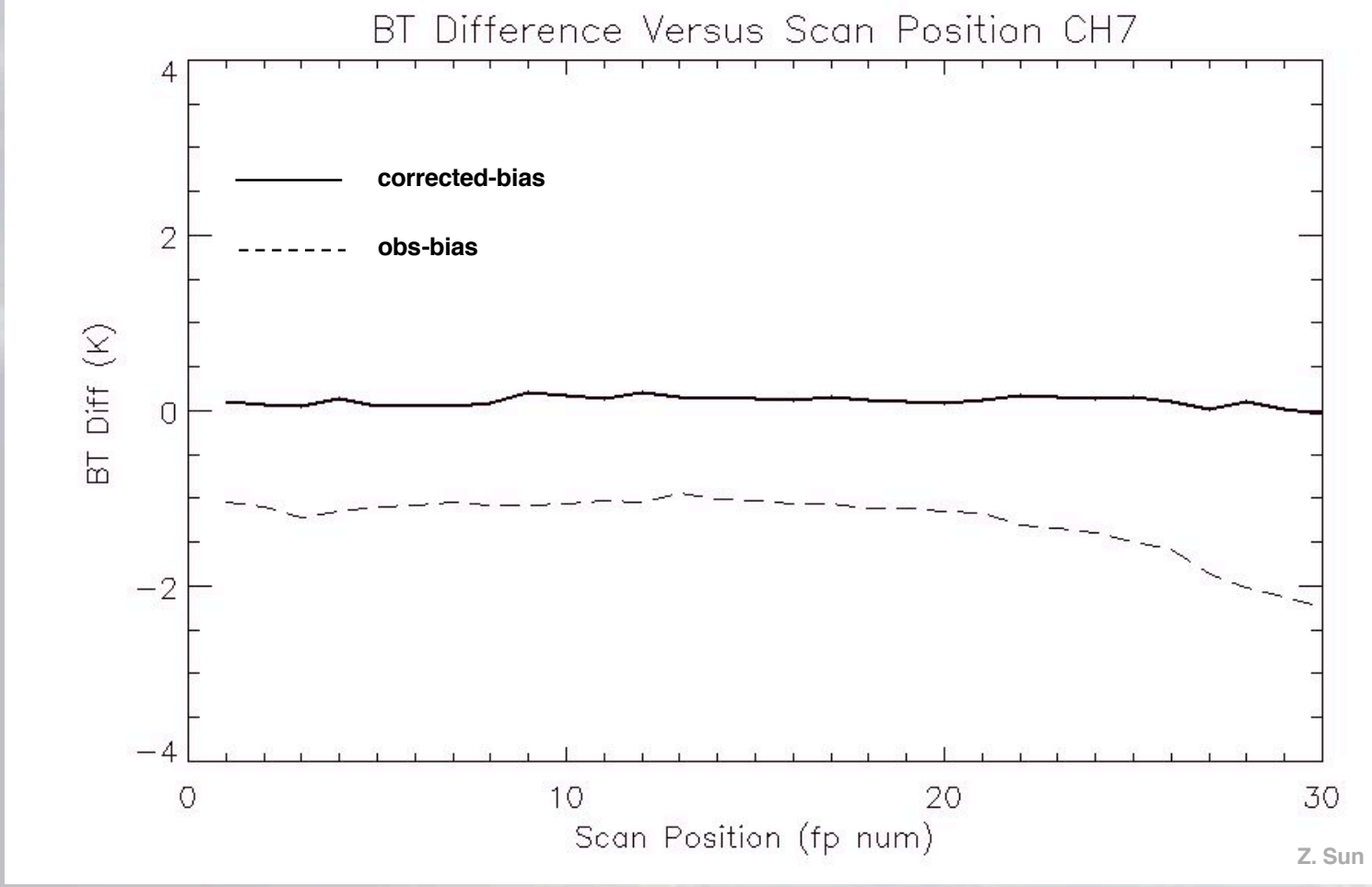
Empirical Scan Bias Correction: Ch. 7



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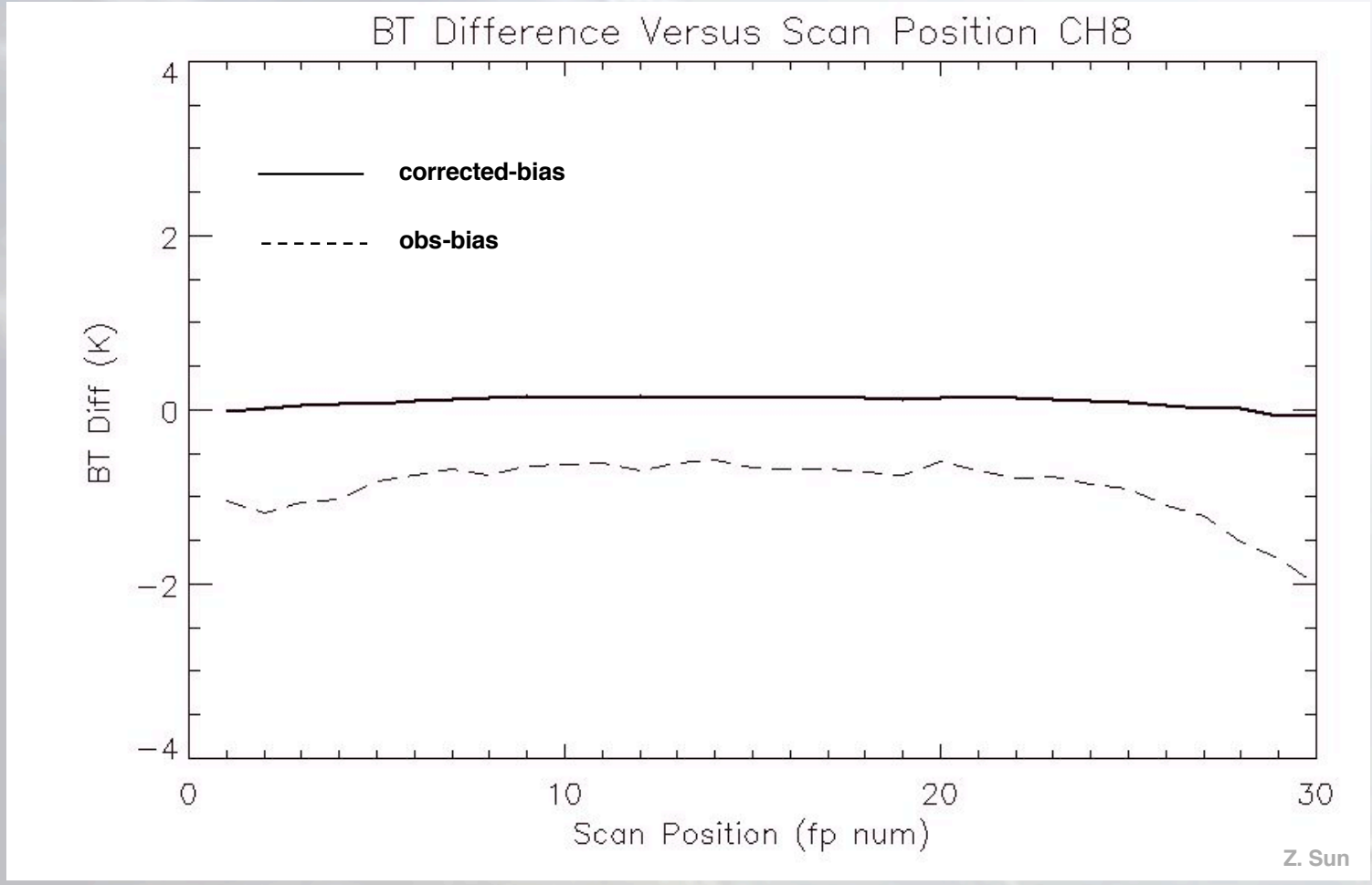
Empirical Scan Bias Correction: Ch. 8



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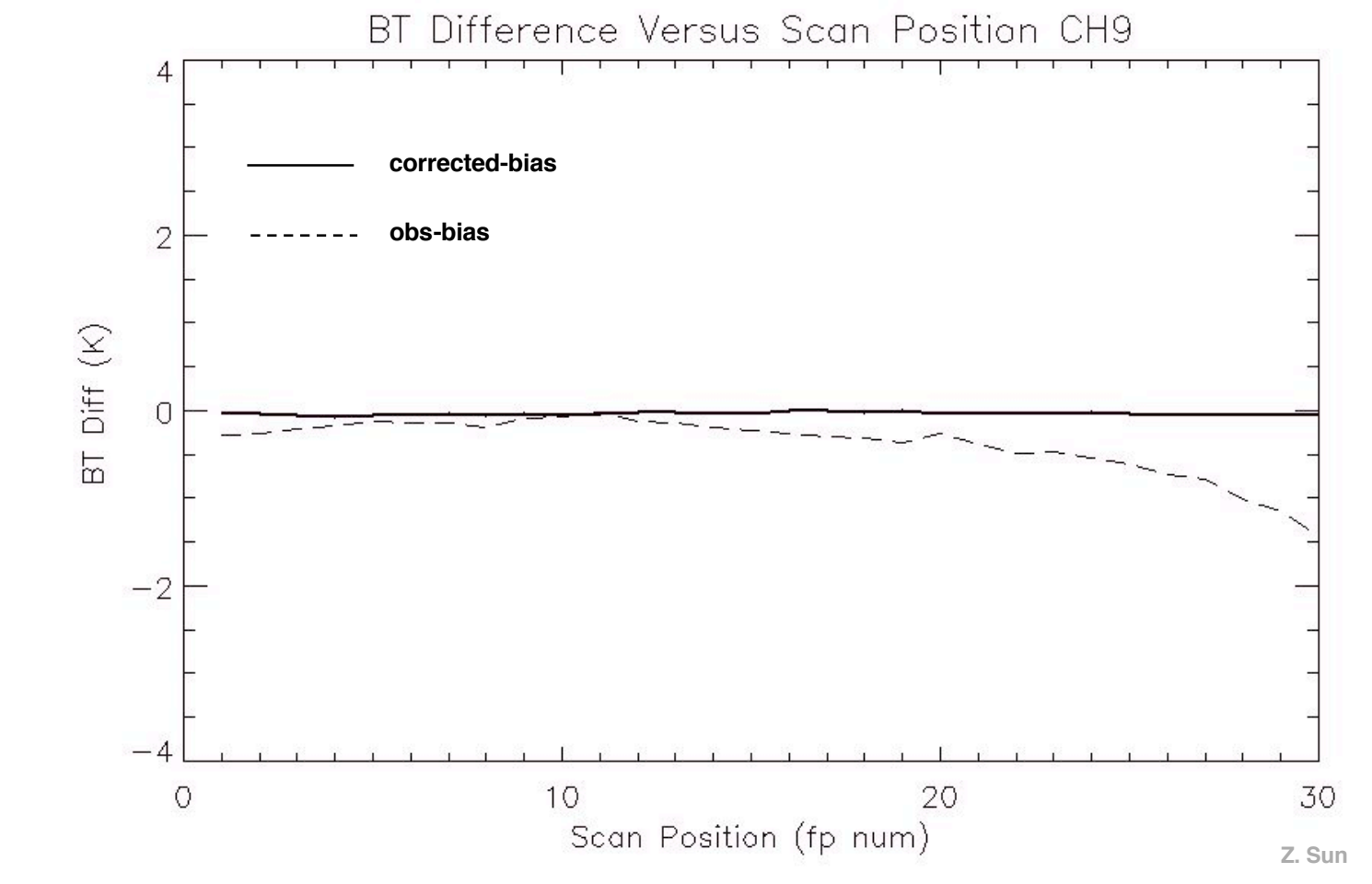
Empirical Scan Bias Correction: Ch. 9



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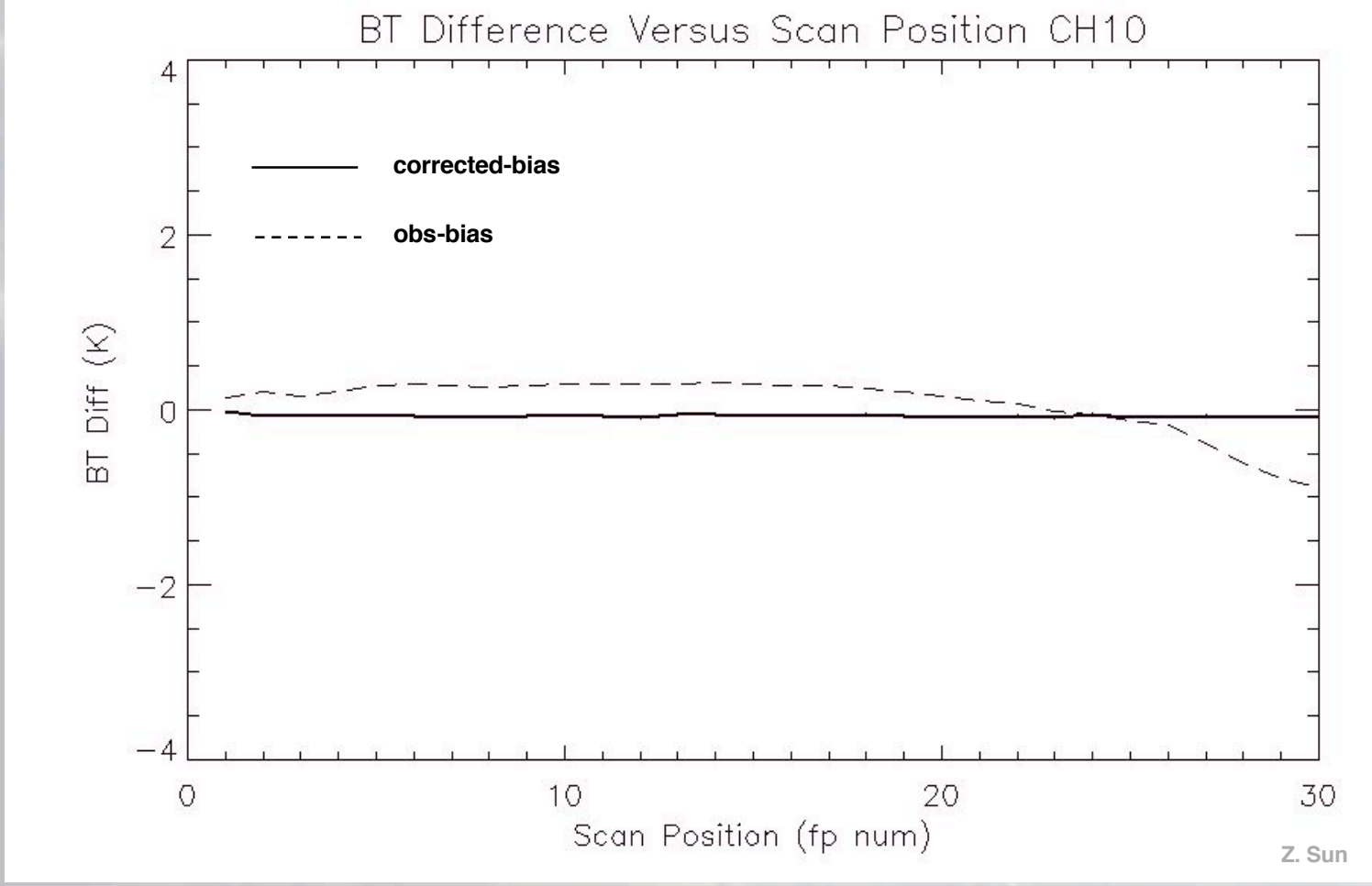
Empirical Scan Bias Correction: Ch. 10



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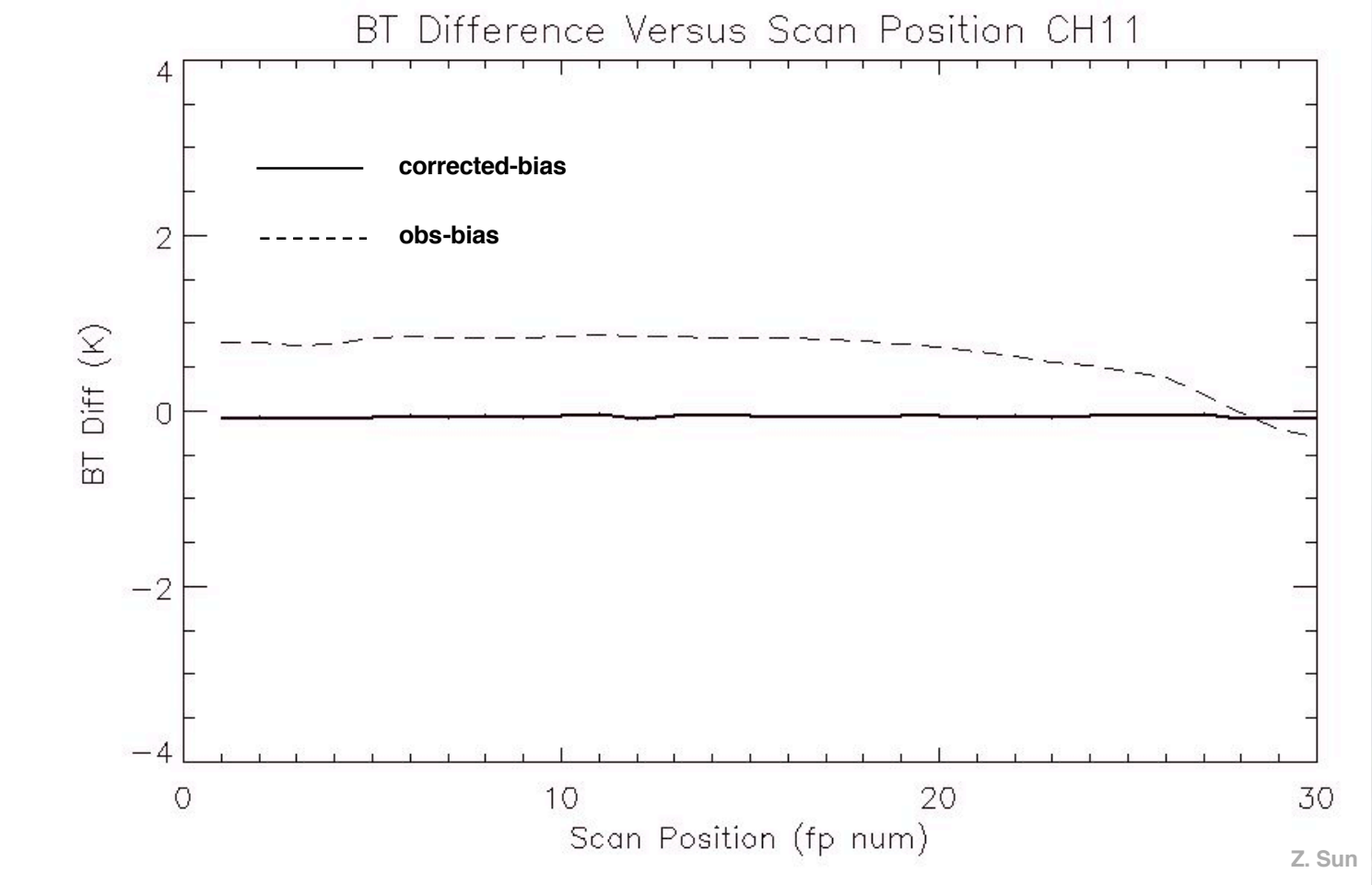
Empirical Scan Bias Correction: Ch. 11



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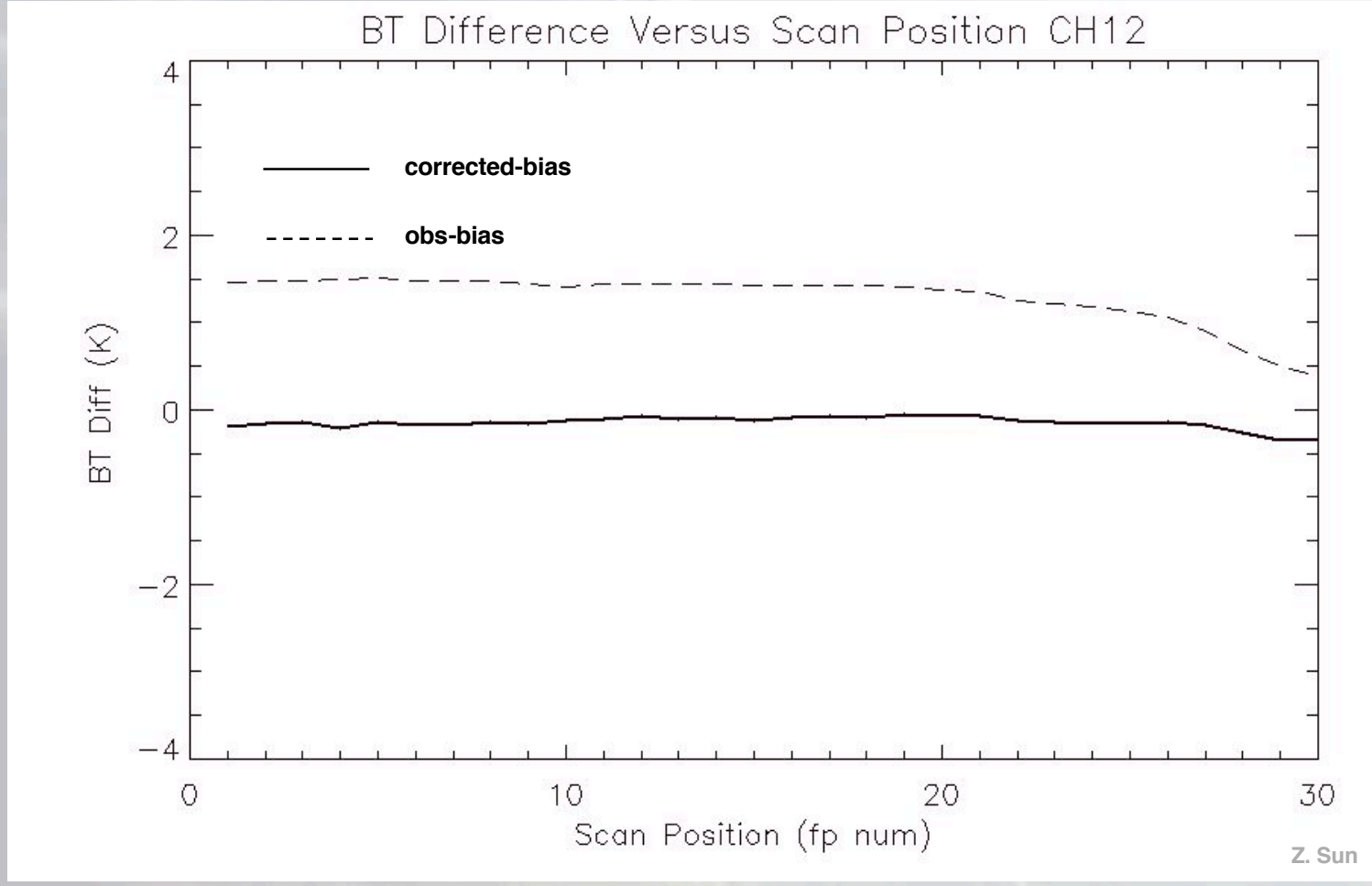
Empirical Scan Bias Correction: Ch. 12



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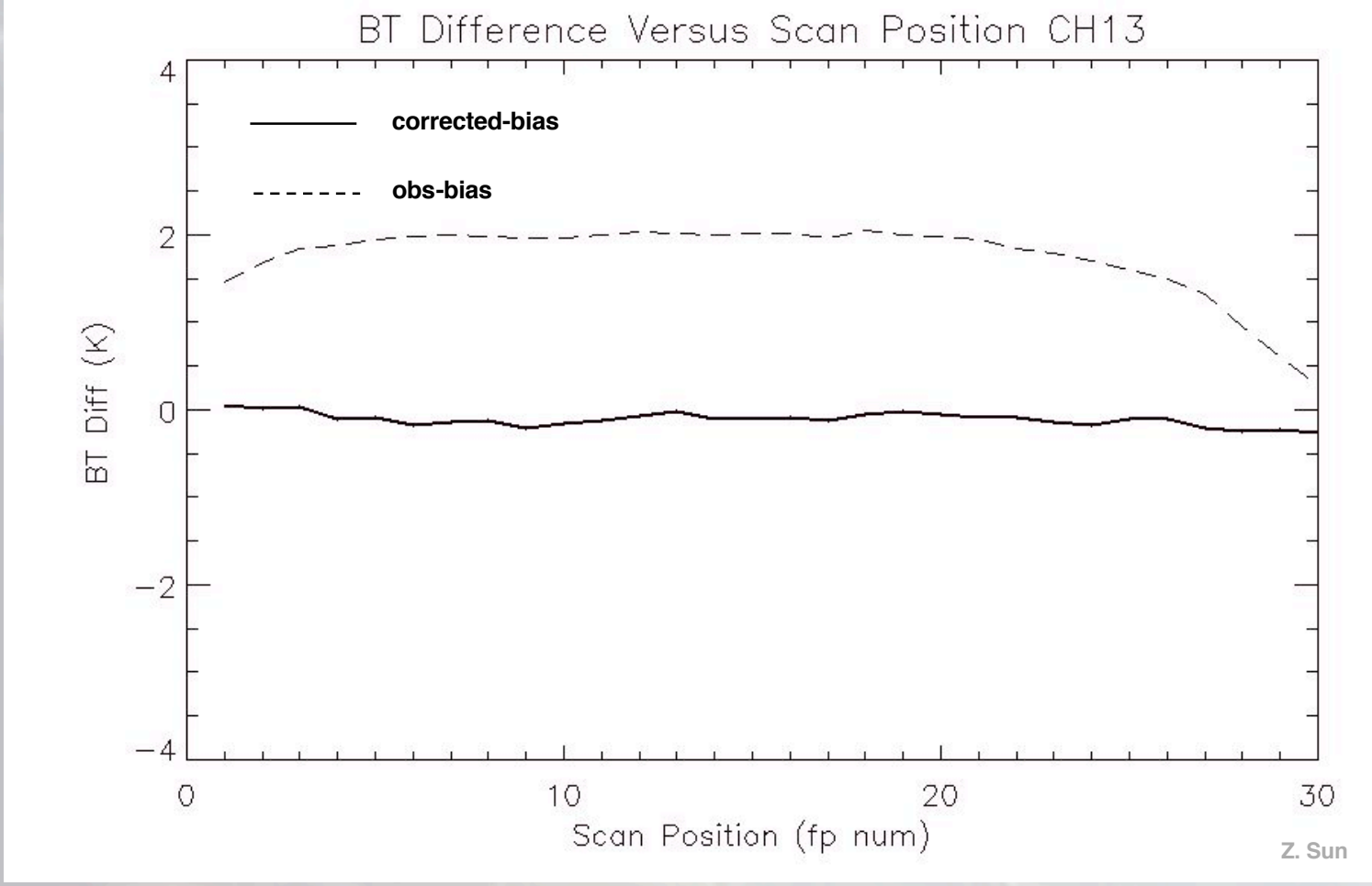
Empirical Scan Bias Correction: Ch. 13



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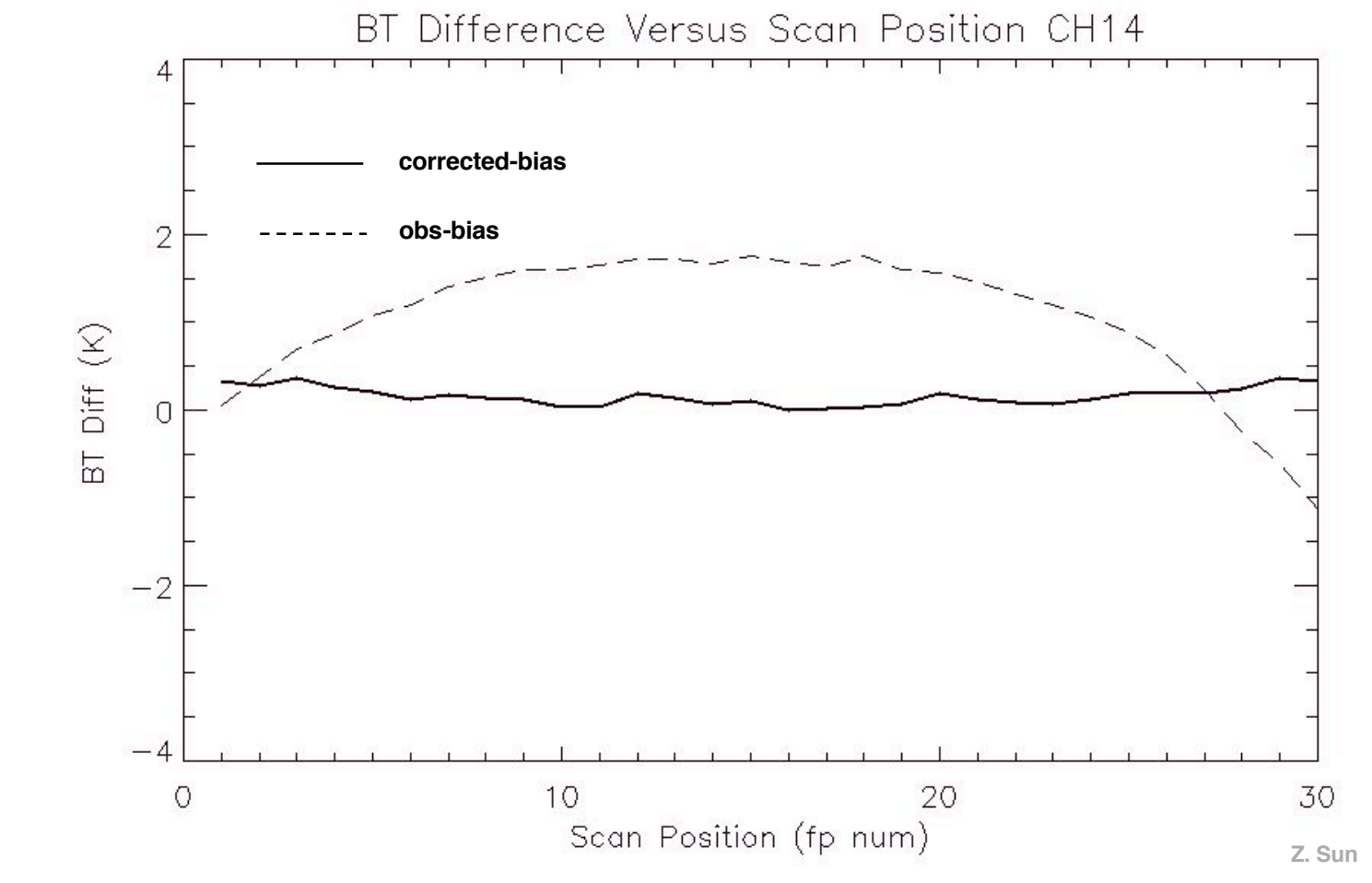
Empirical Scan Bias Correction: Ch. 14



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Conclusions and Further Work

- **Empirical bias corrections look good**
- **May be "best" tuning, but need to be tested on wider data**
  - ***Coefficients derived from "clear/ocean/±30°/Sep.6'02"***
  - ***Tested on "all/±80°/Sep.6'02"***
- **Coefficients could be provided to users as ancillary tables**
- **However:**
  - ***For climate use, bias corrections MUST be physically based***
    - "Tuning" puts data independence at risk
    - Climate signals could be "tuned" out
  - ***Therefore***
    - We should only put empirical correction into L1b as a last resort
    - We may provide empirical coefficients as ancillary tables

- **For V5 the goal is to derive BETTER physically based coefficients**
  - ***Try to get CLOSER agreement with empirical coefficients***
  - ***Then use mostly model-based + a few empirical substitutes***

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Backup Slides

- **Gain variations**
- **AMSU & AIRS obs & sim vs. scan**
- **Sim[AIRS] vs. Sim[ECMWF]**
- **Obs-Sim: AIRS vs. ECMWF**
- **Scan bias correction coefficients**
- **Empirical scan bias correction**

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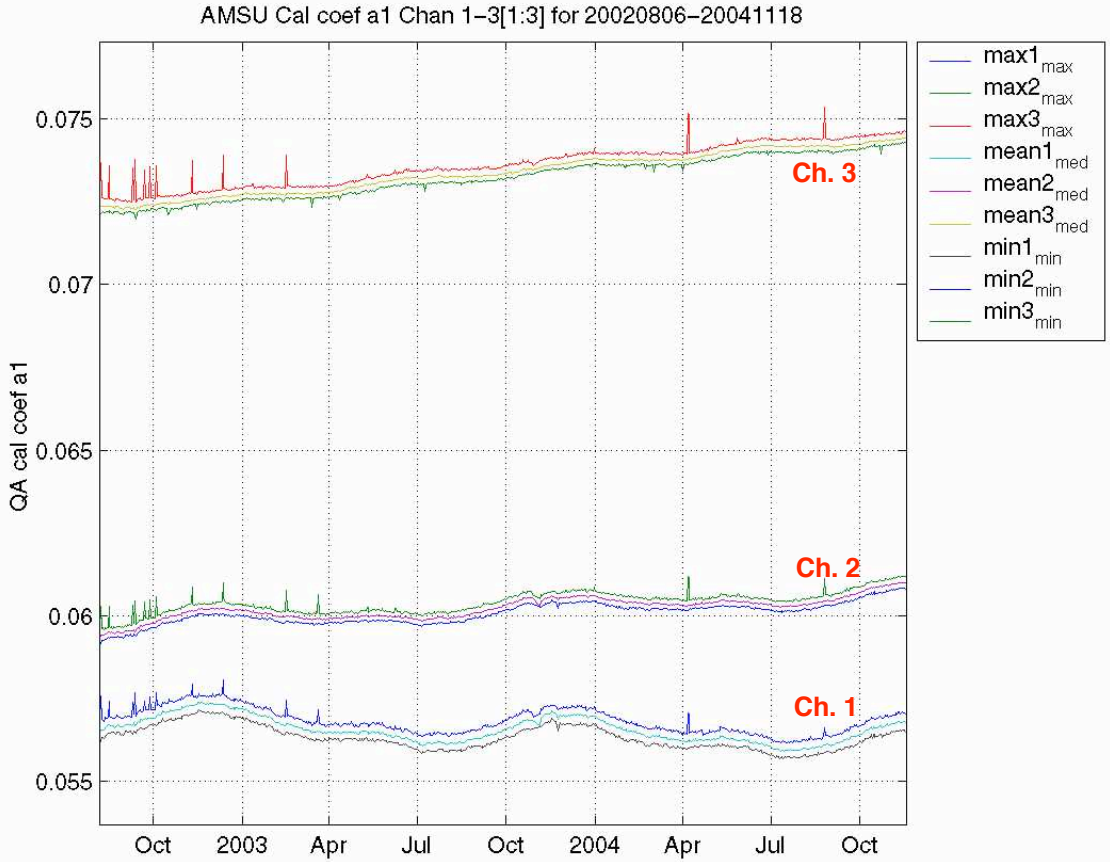
AMSU Gain Variation: Ch. 1-3

Shown: calibration coefficient $a_1 \approx 1/\text{gain}$

Channels 1-2 show only minor orbital gain variation

Channel 3 shows minor gain decline: about 1% per year



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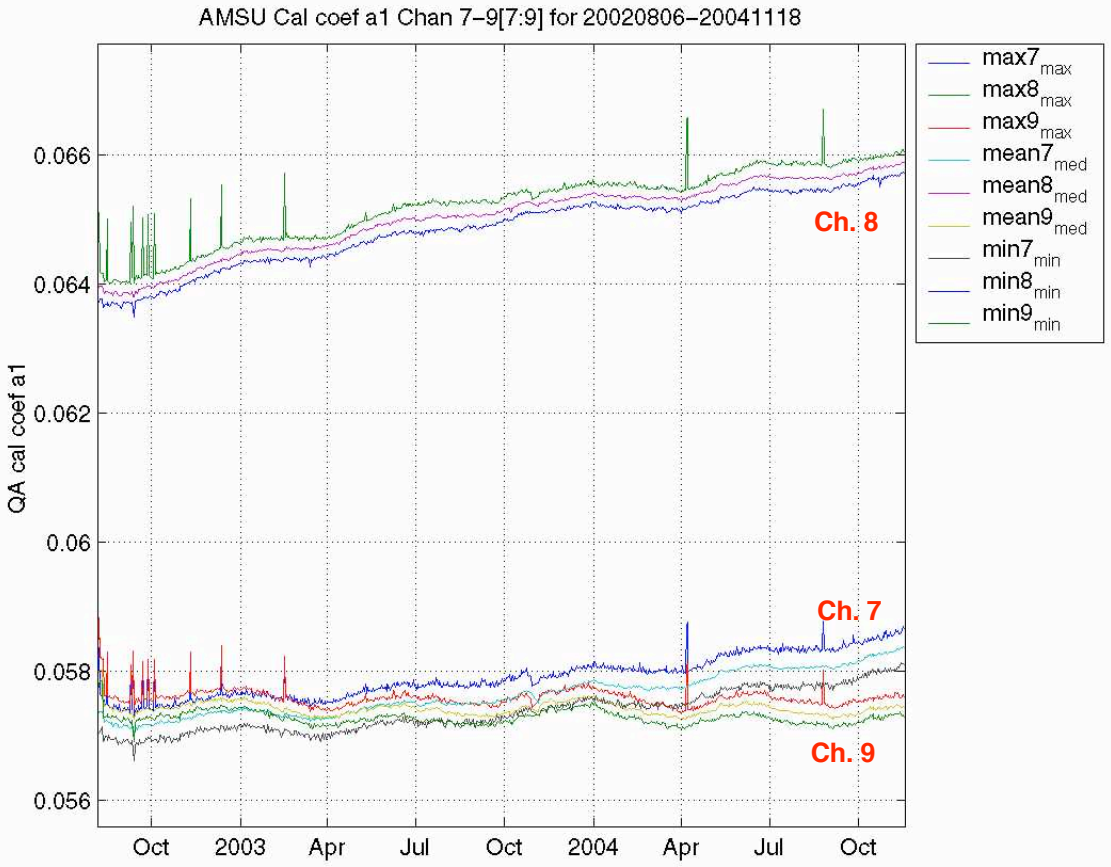
AMSU Gain Variation: Ch. 7-9

Shown: calibration coefficient $a_1 \approx 1/\text{gain}$

Only minor gain changes for these channels



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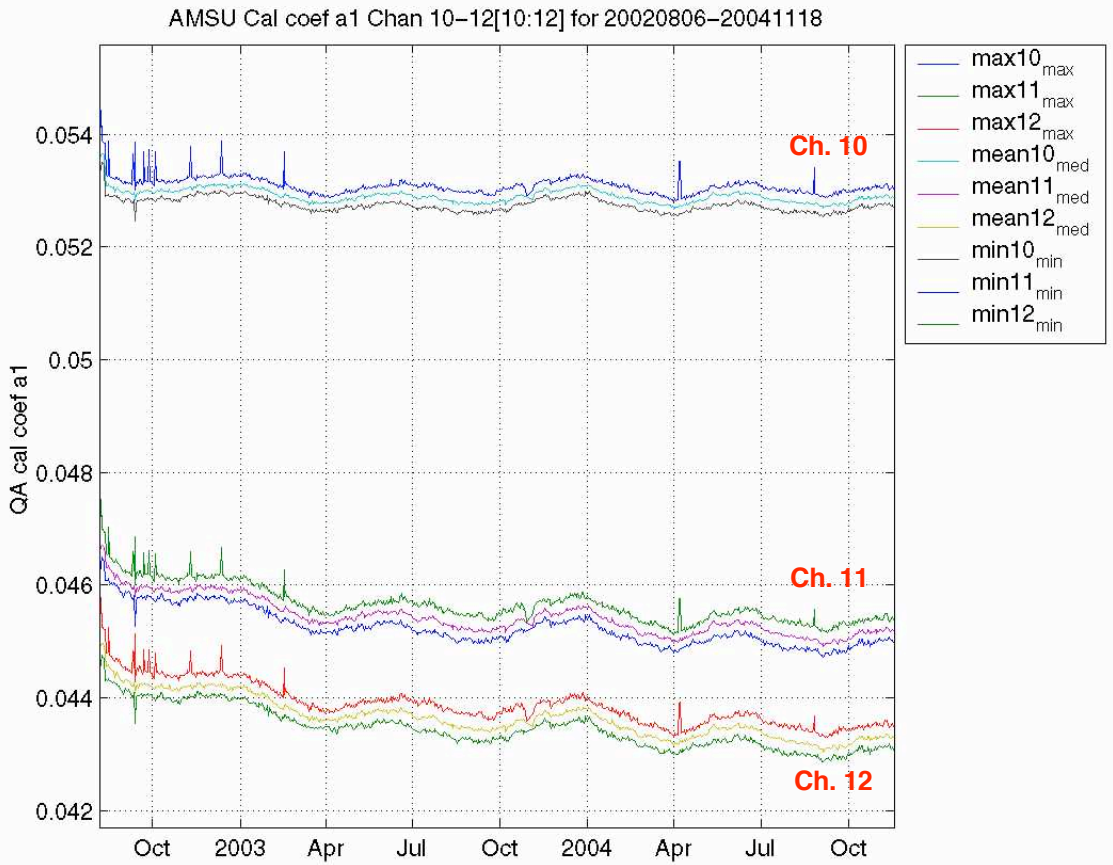
AMSU Gain Variation: Ch. 10-12

Shown: calibration coefficient $a_1 \approx 1/\text{gain}$

Only minor gain changes for these channels



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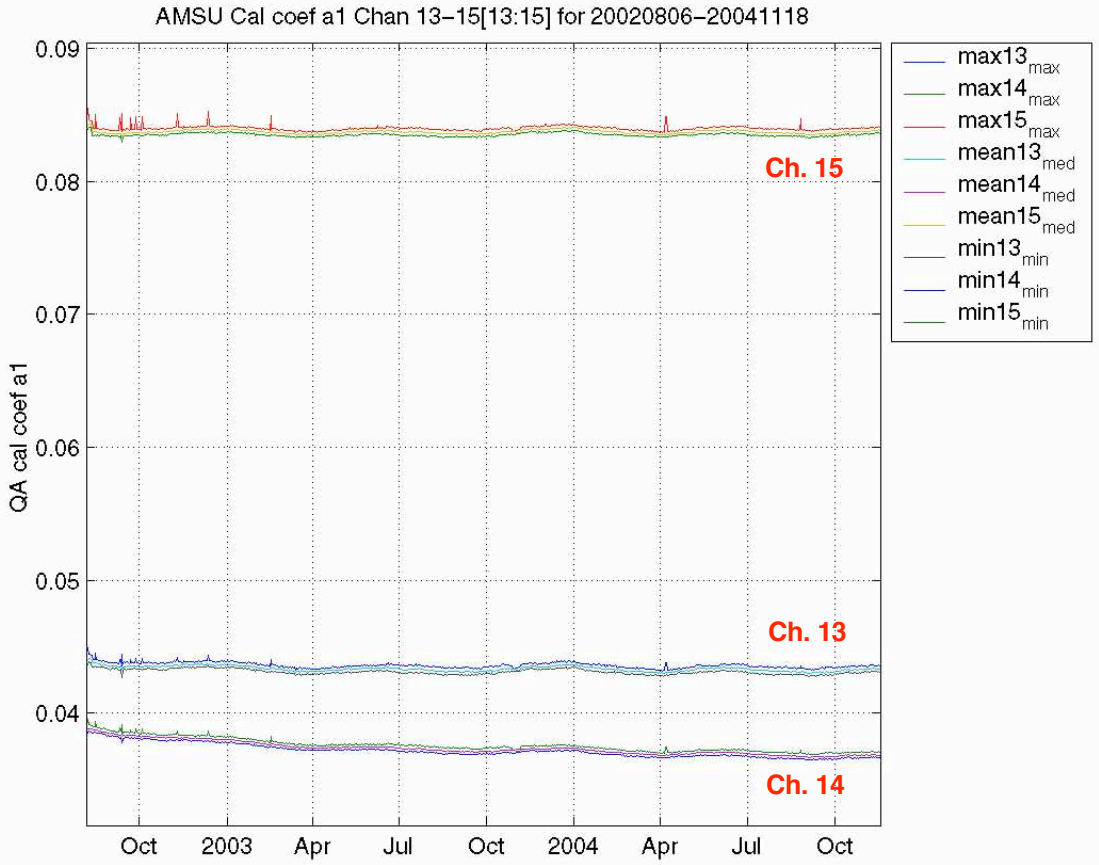
AMSU Gain Variation: Ch. 13-15

Shown: calibration coefficient $a_1 \approx 1/\text{gain}$

Negligible gain changes for these channels



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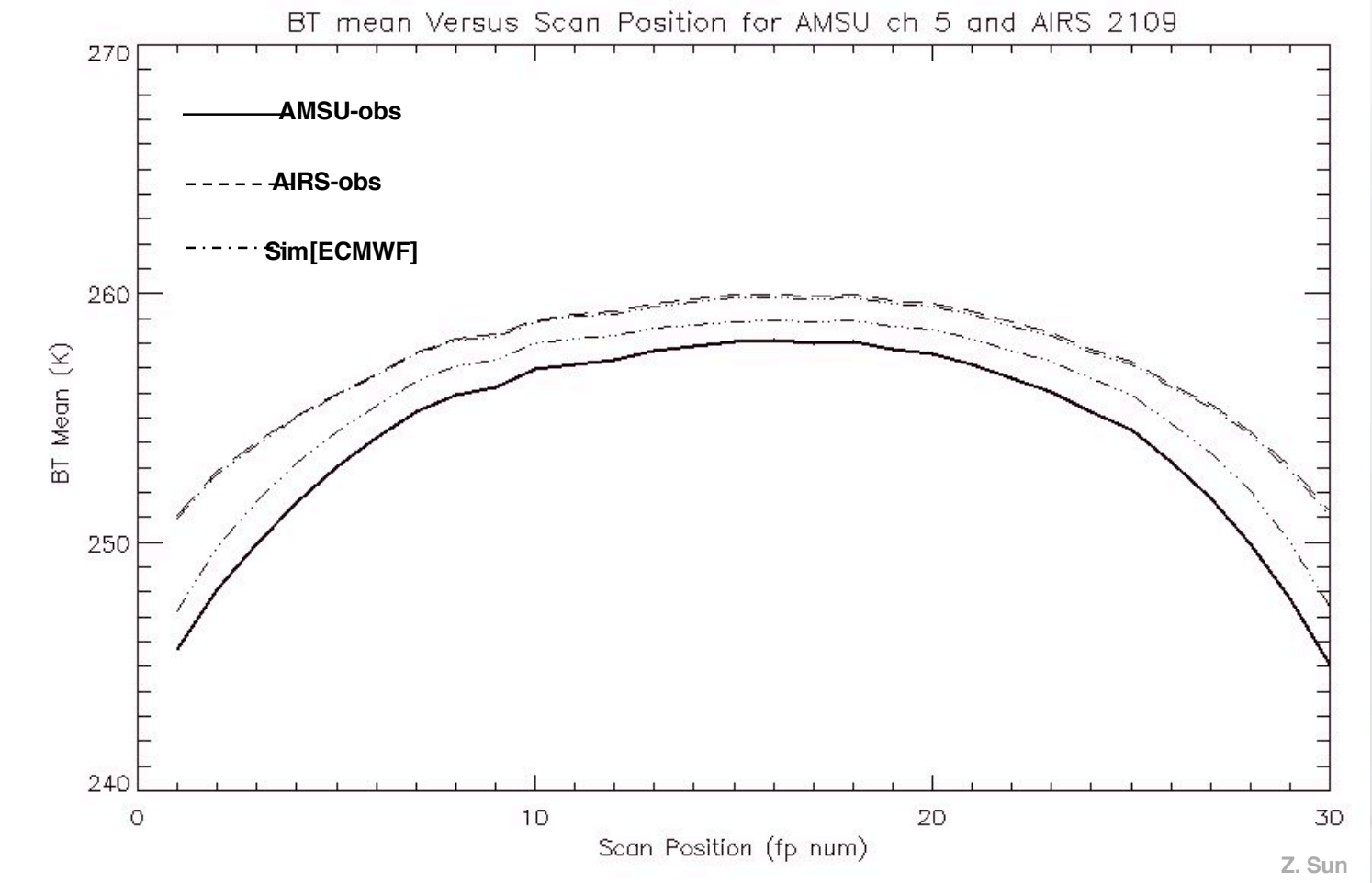
AMSU & AIRS obs & sim vs. scan: Ch. 5



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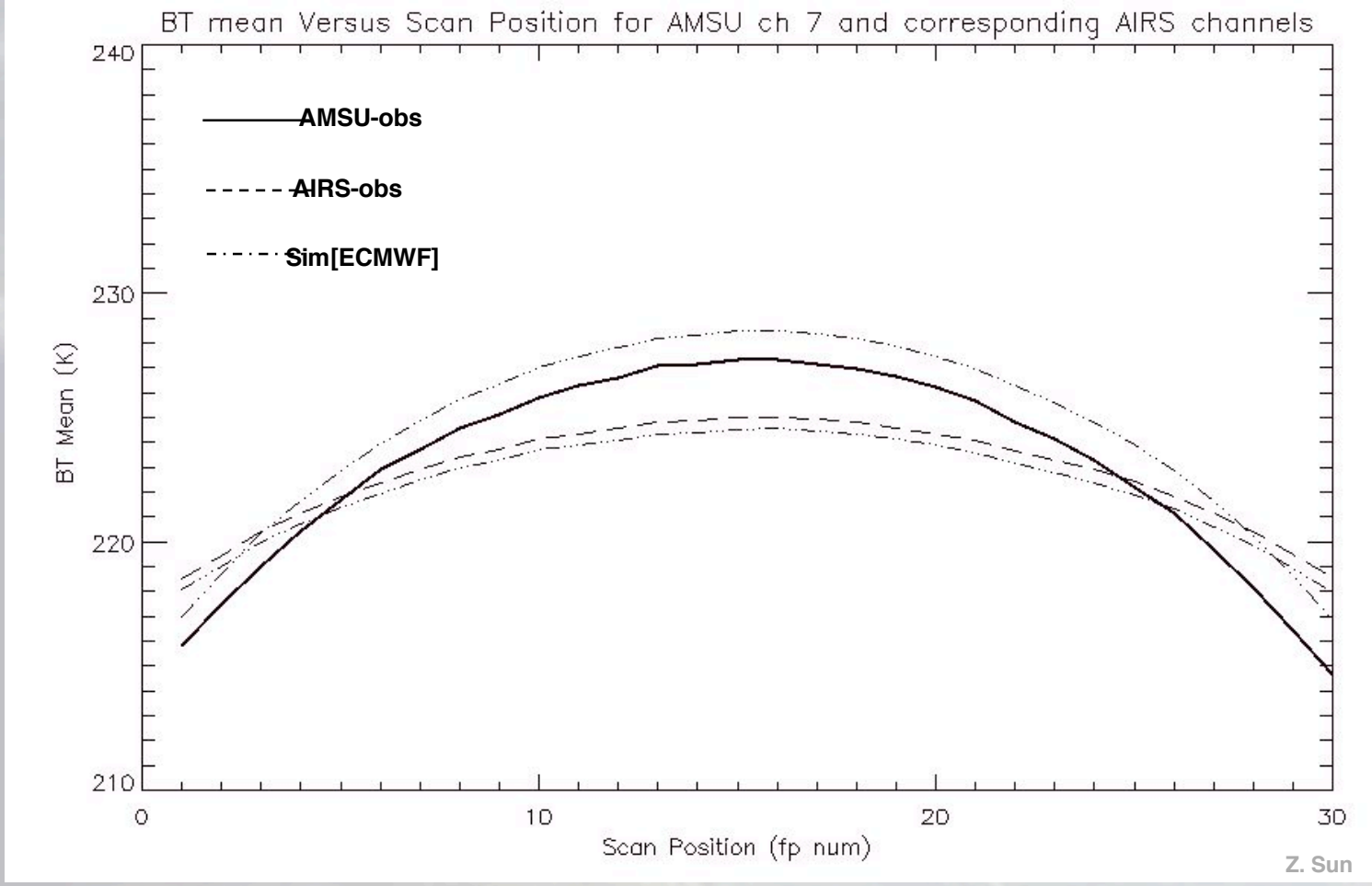
AMSU & AIRS obs & sim vs. scan: Ch. 7



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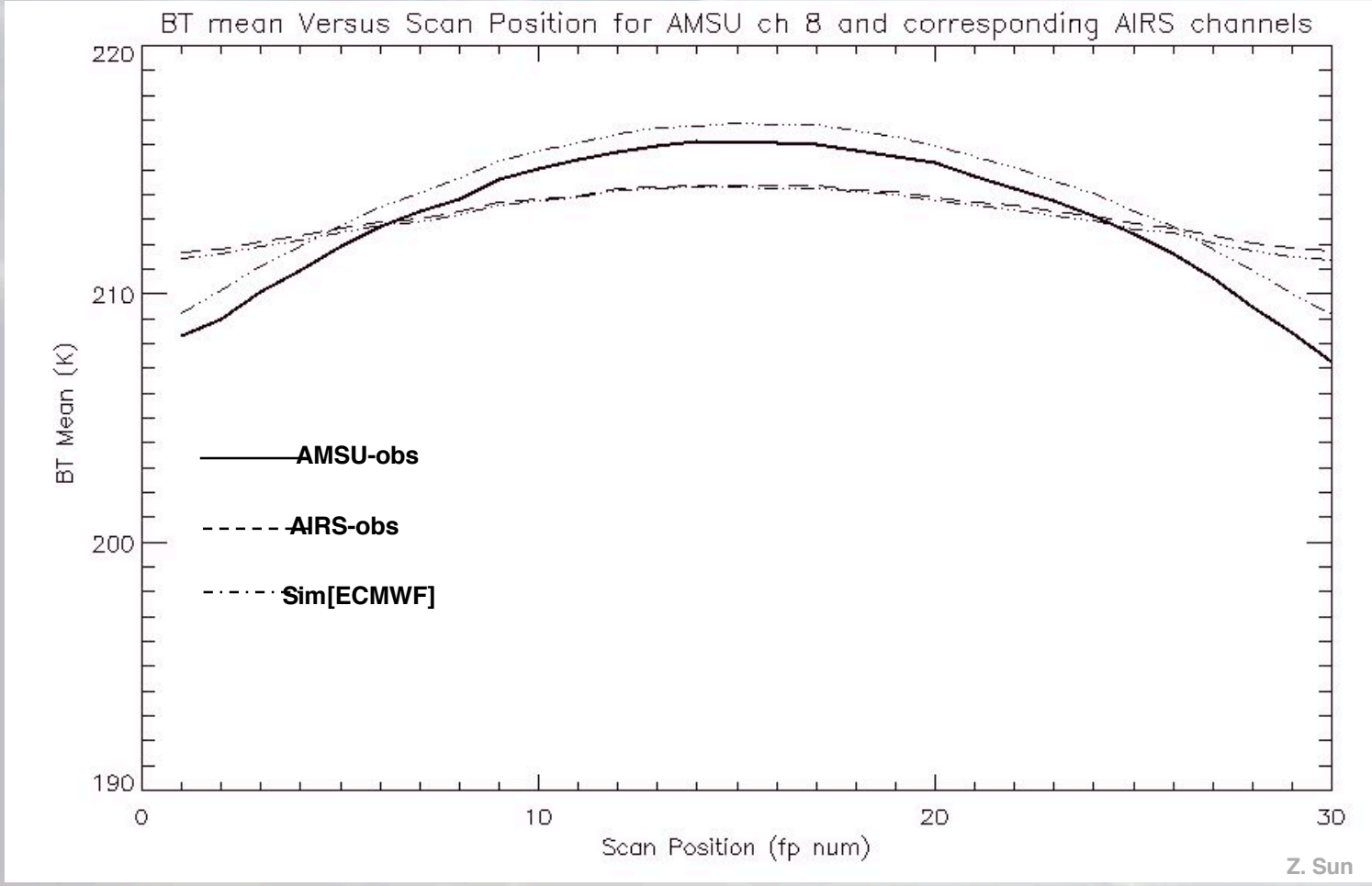
AMSU & AIRS obs & sim vs. scan: Ch. 8



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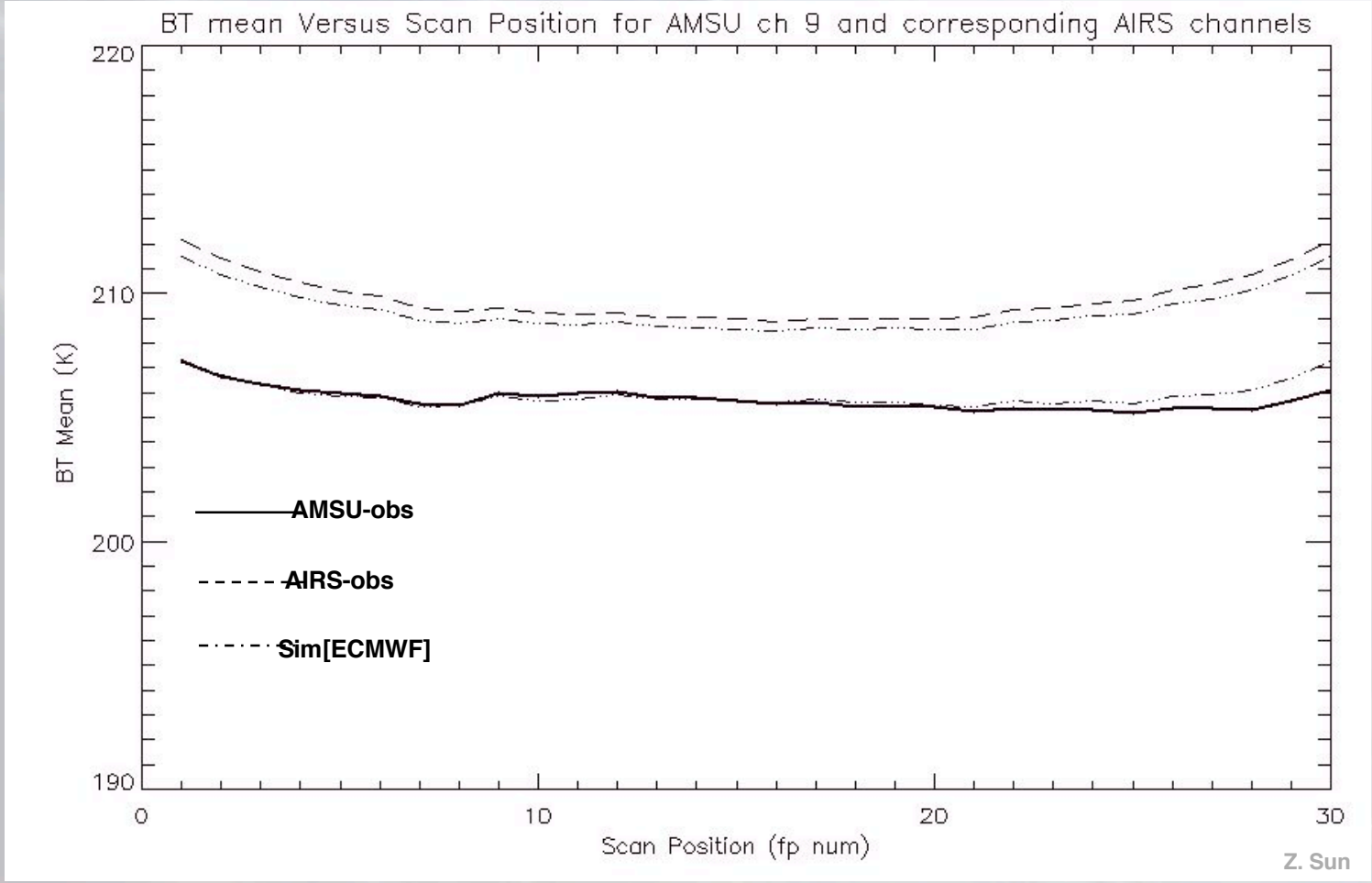
AMSU & AIRS obs & sim vs. scan: Ch. 9



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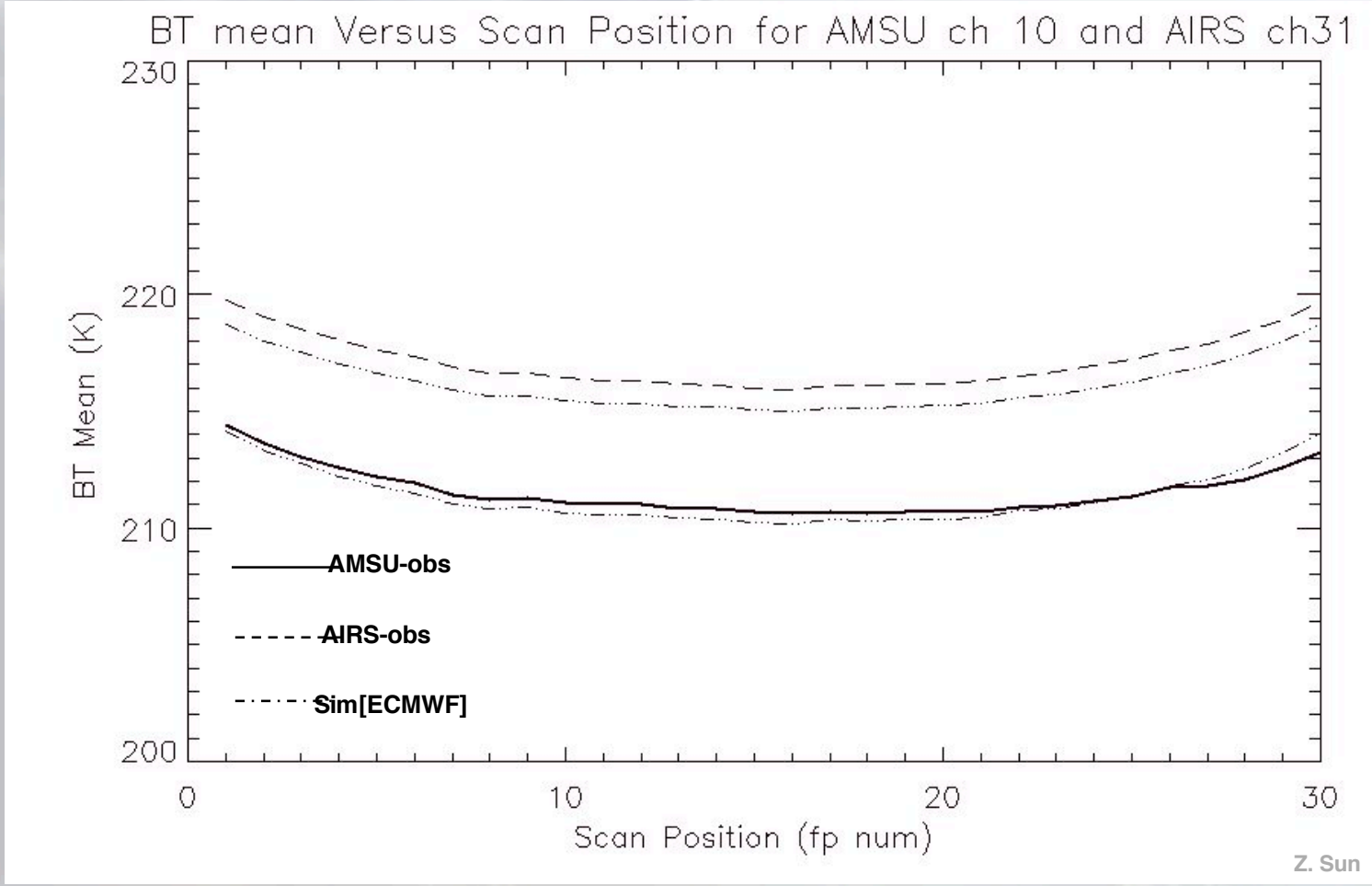
AMSU & AIRS obs & sim vs. scan: Ch. 10



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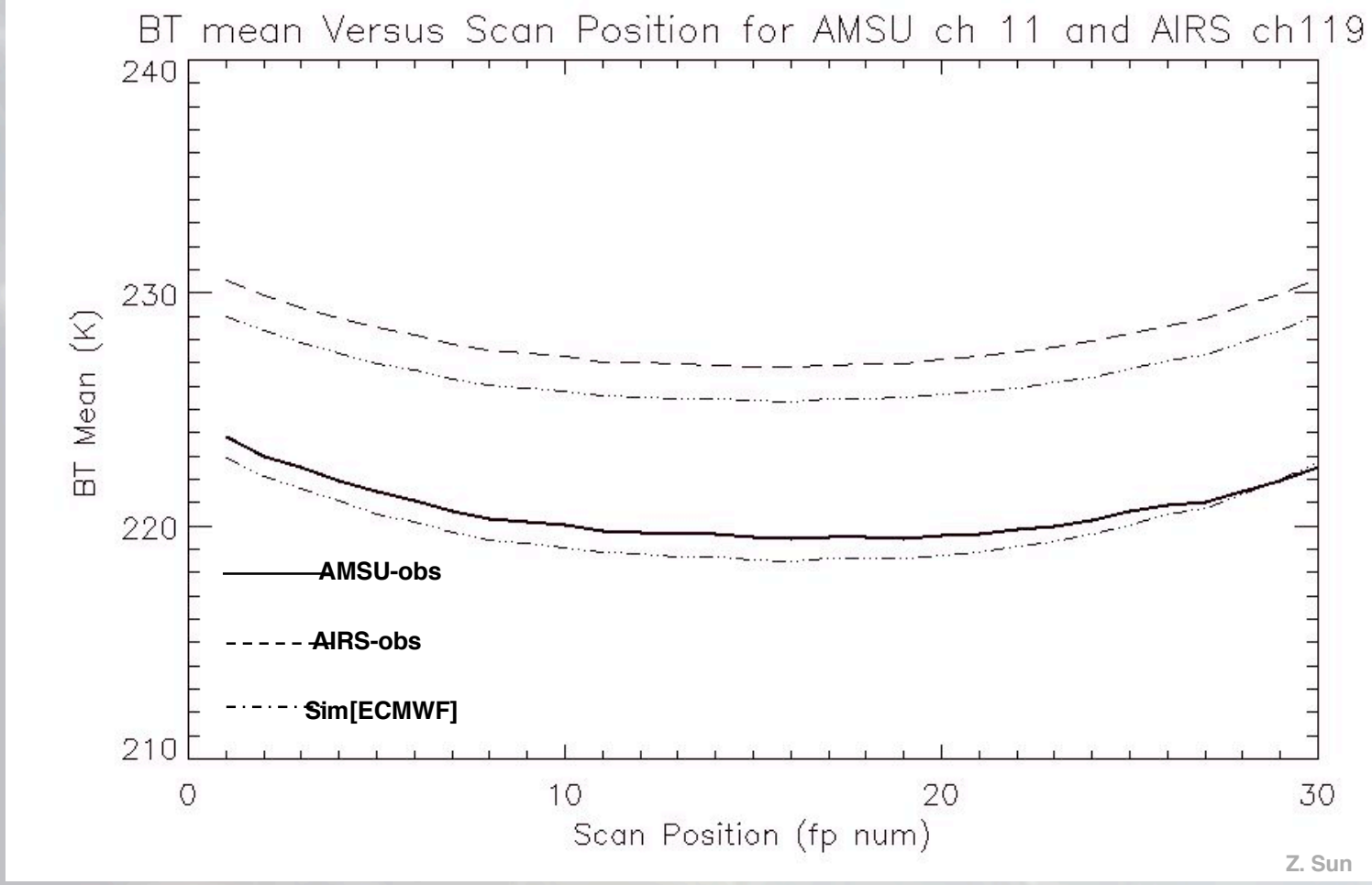
AMSU & AIRS obs & sim vs. scan: Ch. 11



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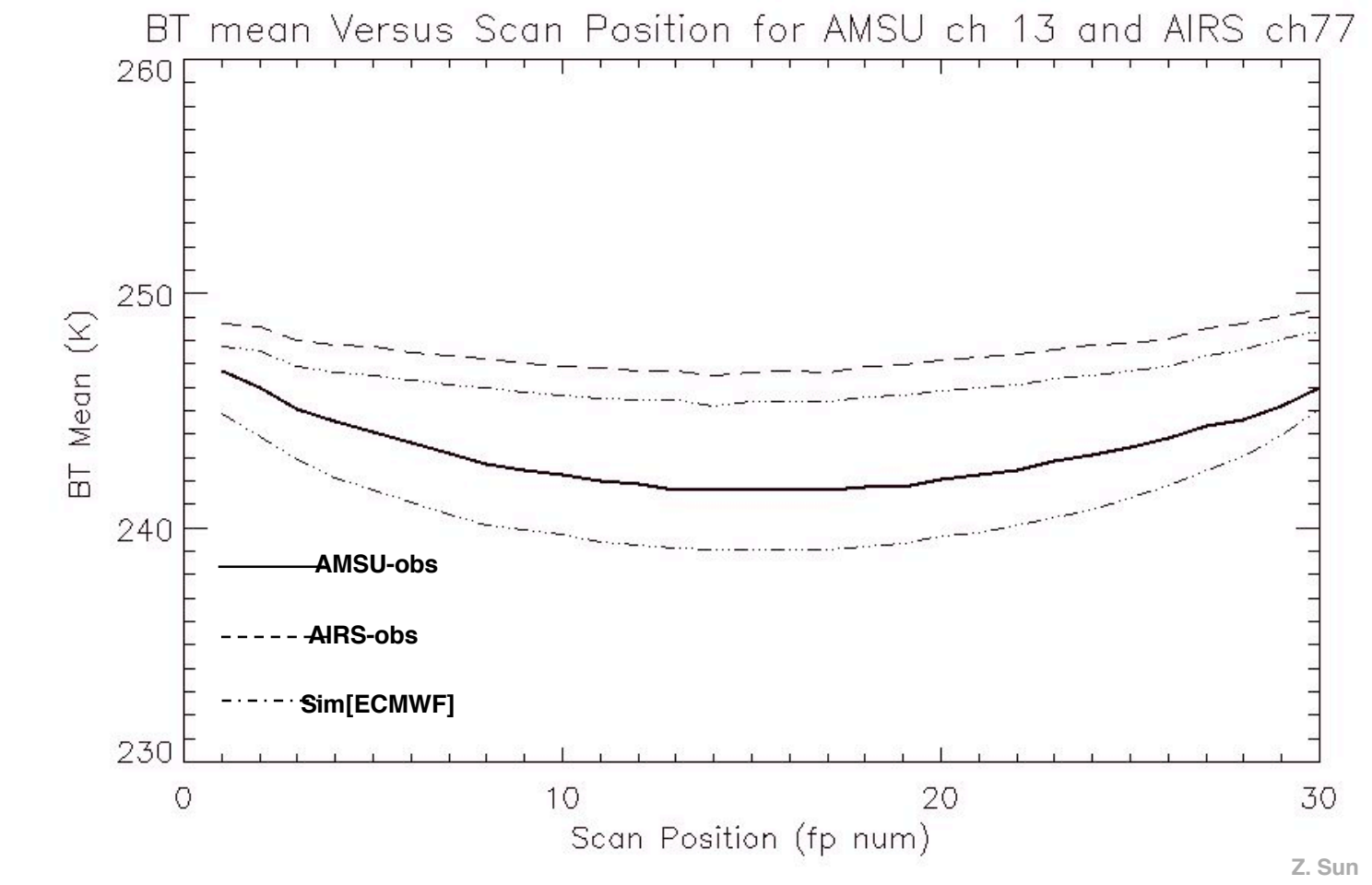
AMSU & AIRS obs & sim vs. scan: Ch. 13



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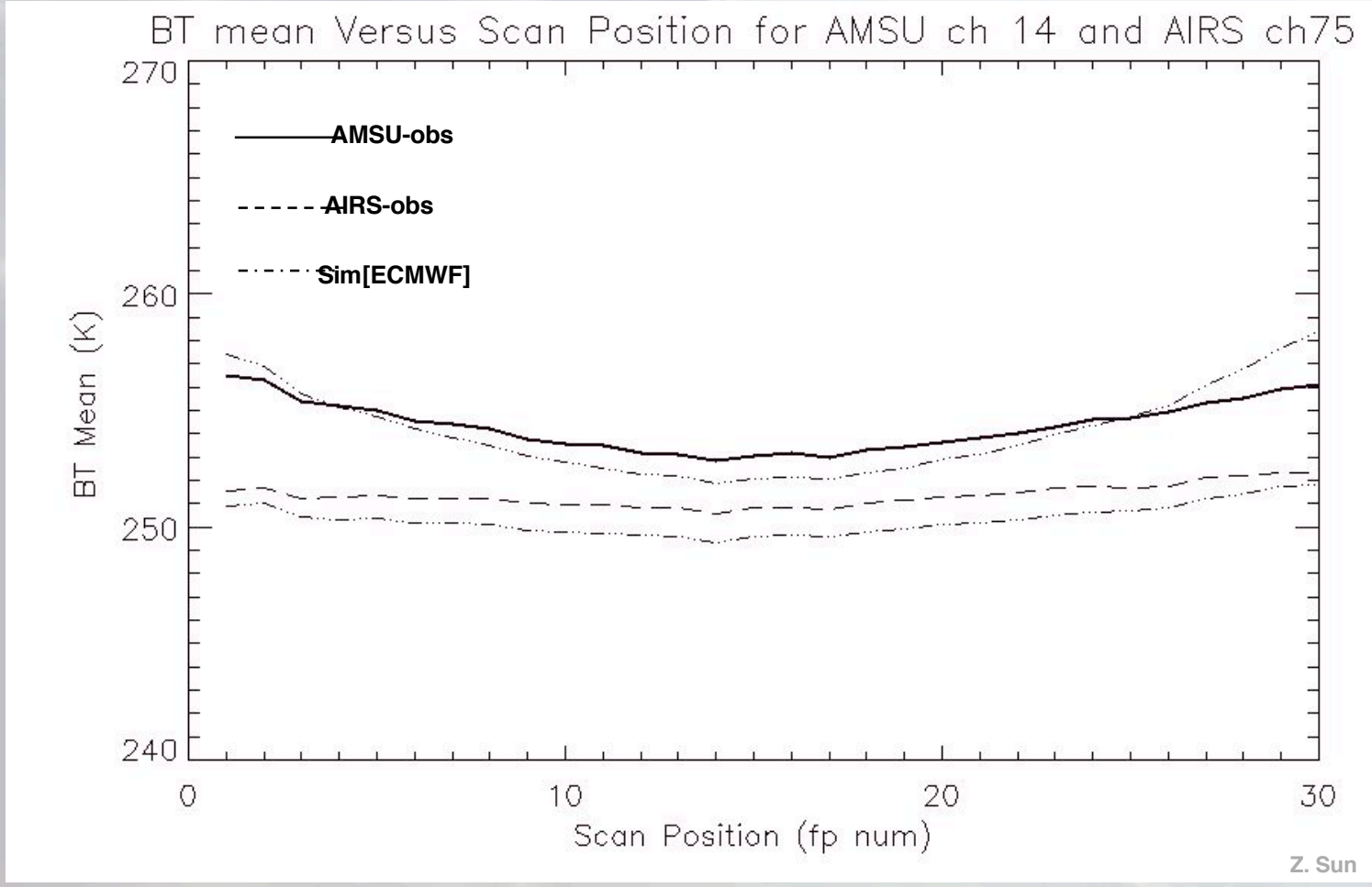
AMSU & AIRS obs & sim vs. scan: Ch. 14



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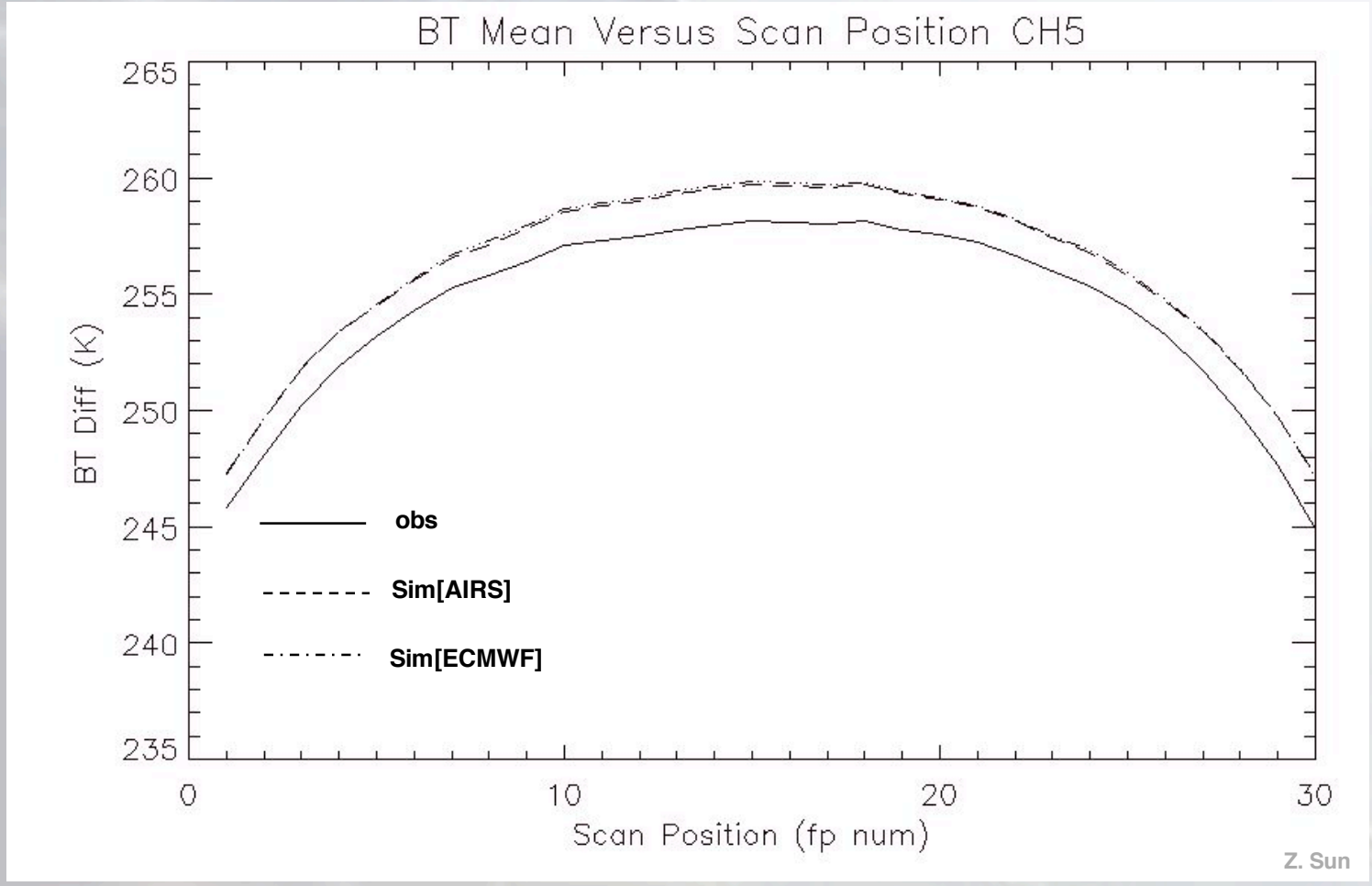
Sim[ECMWF] vs. Sim[AIRS]: Ch. 5



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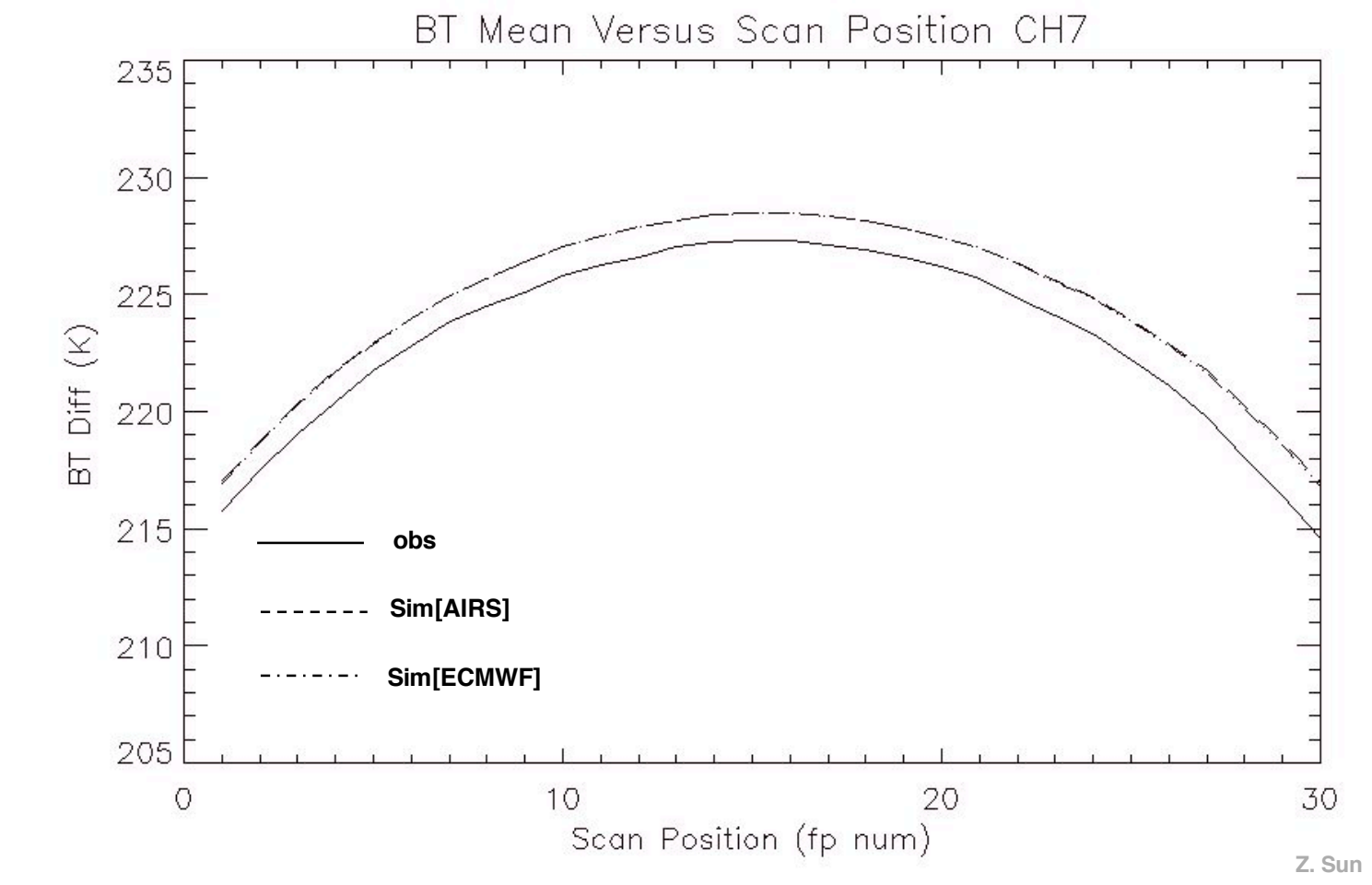
Sim[ECMWF] vs. Sim[AIRS]: Ch. 7



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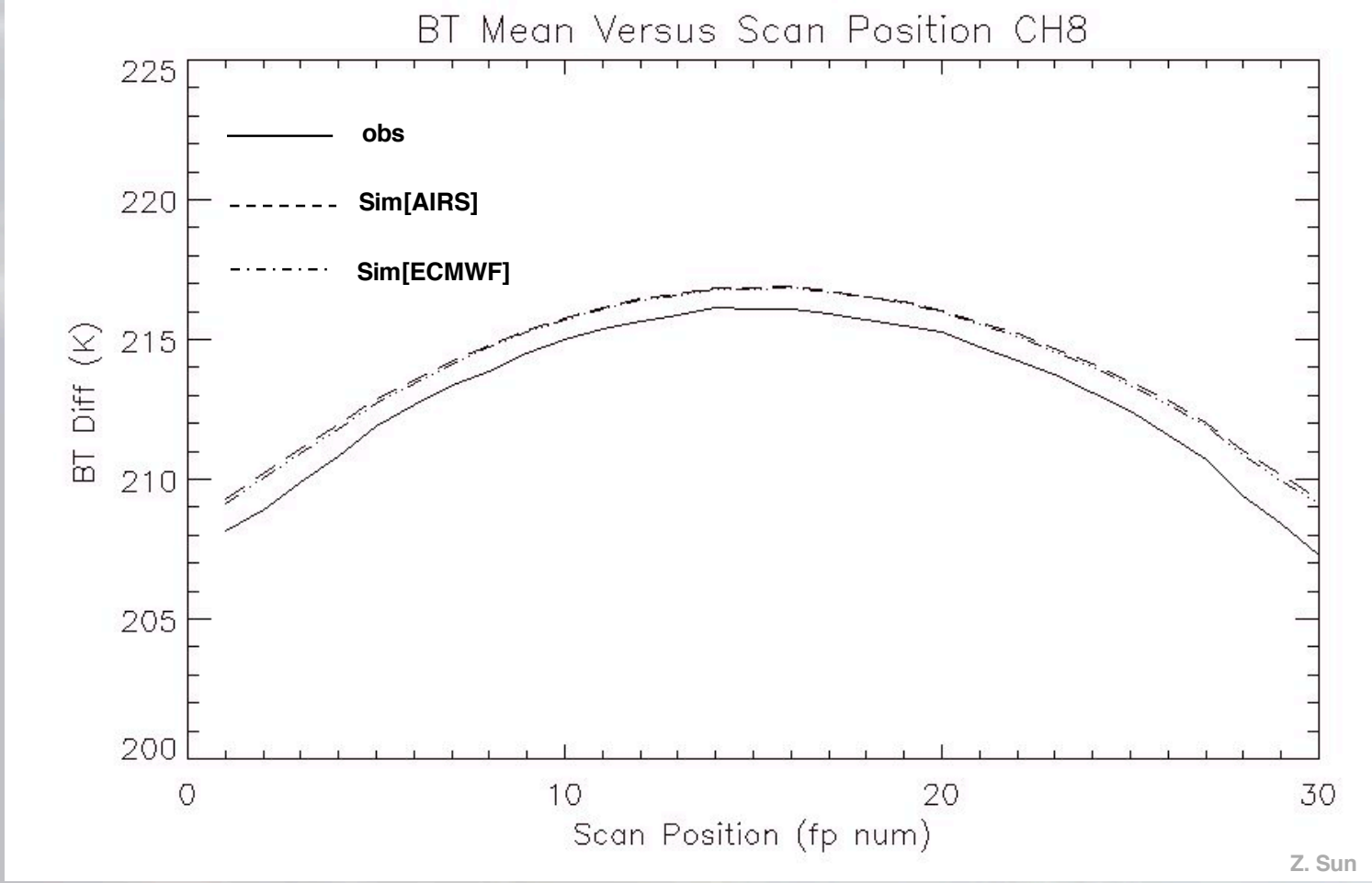
Sim[ECMWF] vs. Sim[AIRS]: Ch. 8



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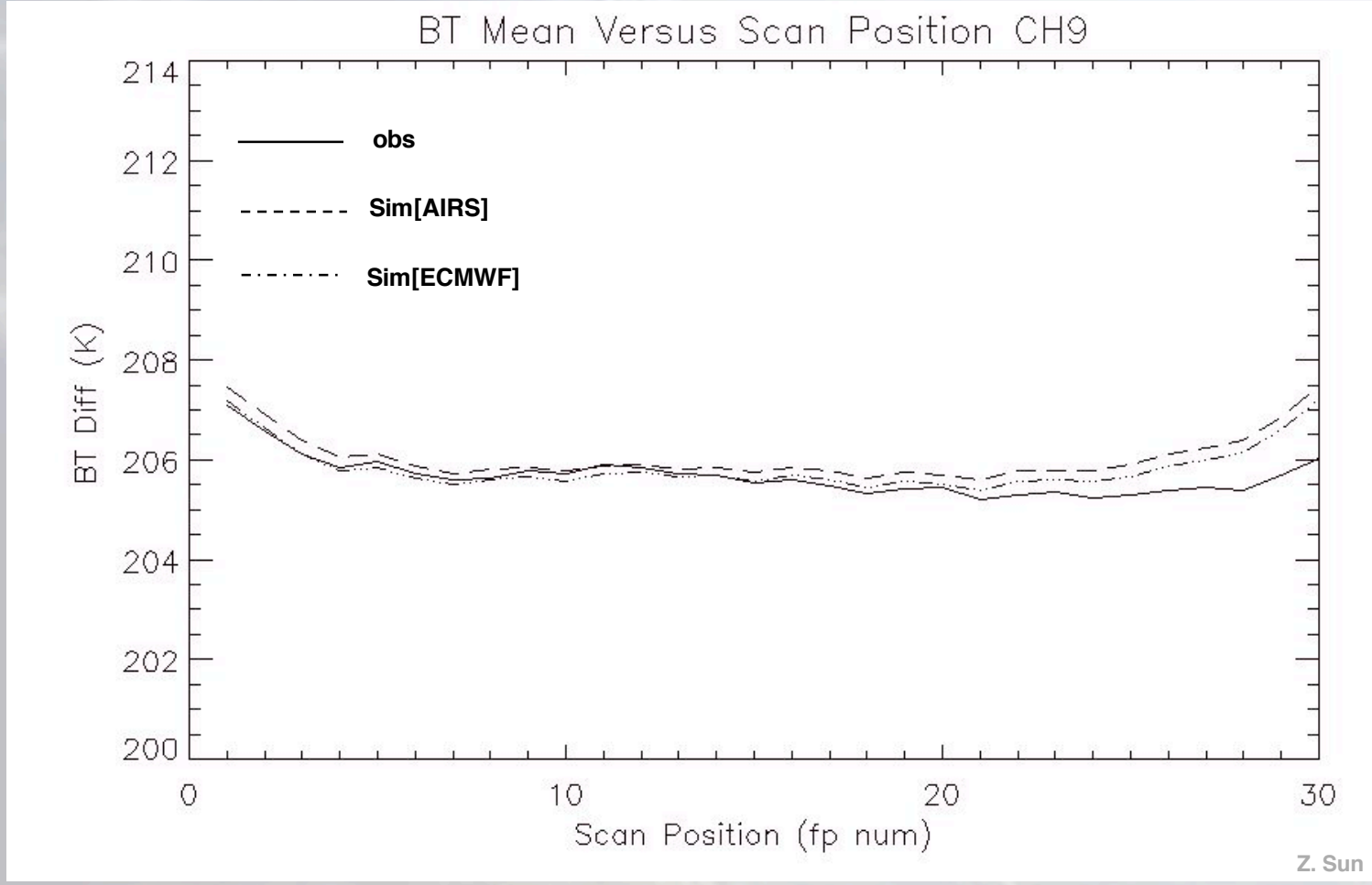
Pasadena, California

Sim[ECMWF] vs. Sim[AIRS]: Ch. 9



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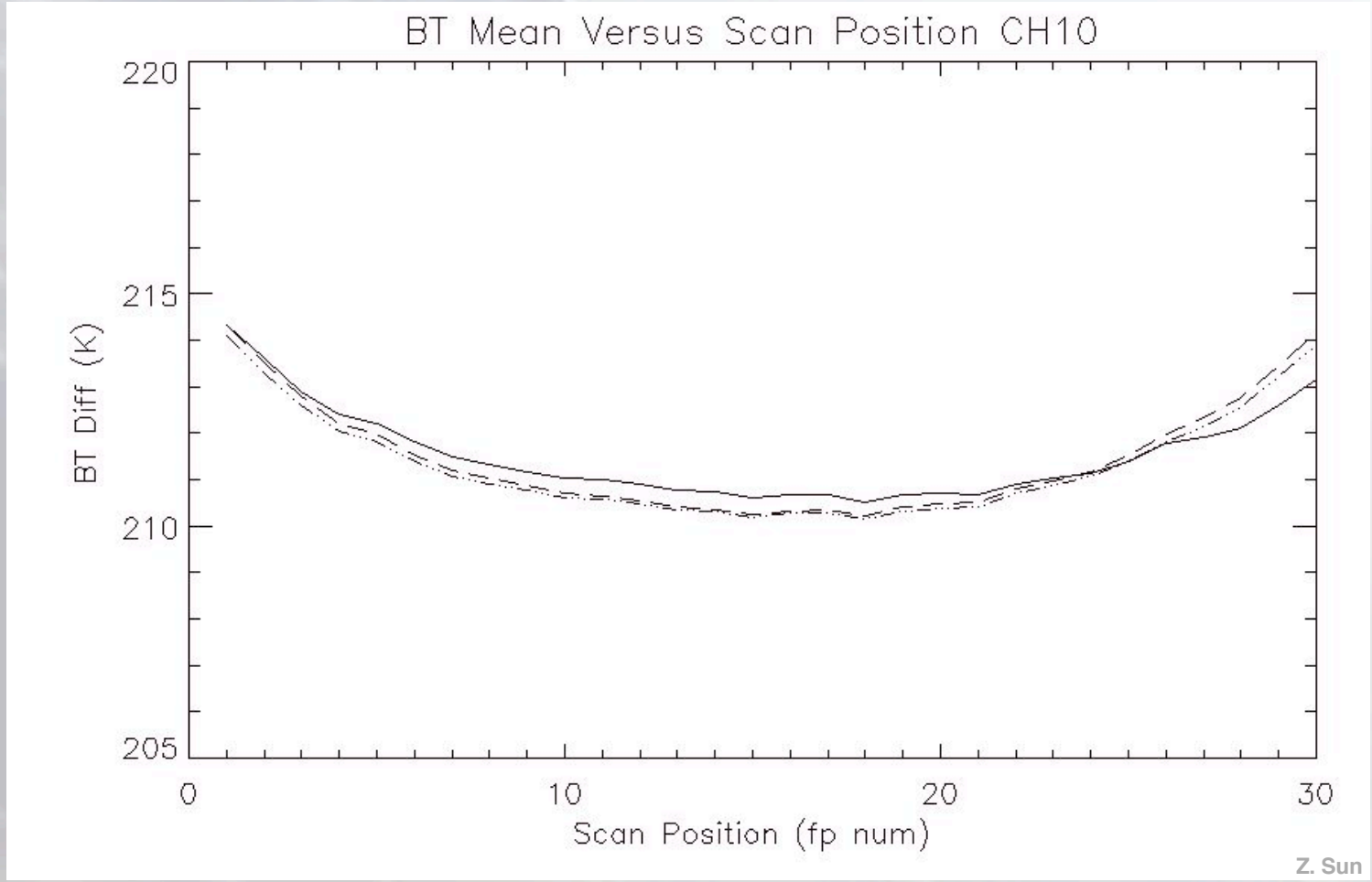
Sim[ECMWF] vs. Sim[AIRS]: Ch. 10

obs

Sim[AIRS]

Sim[ECMWF]



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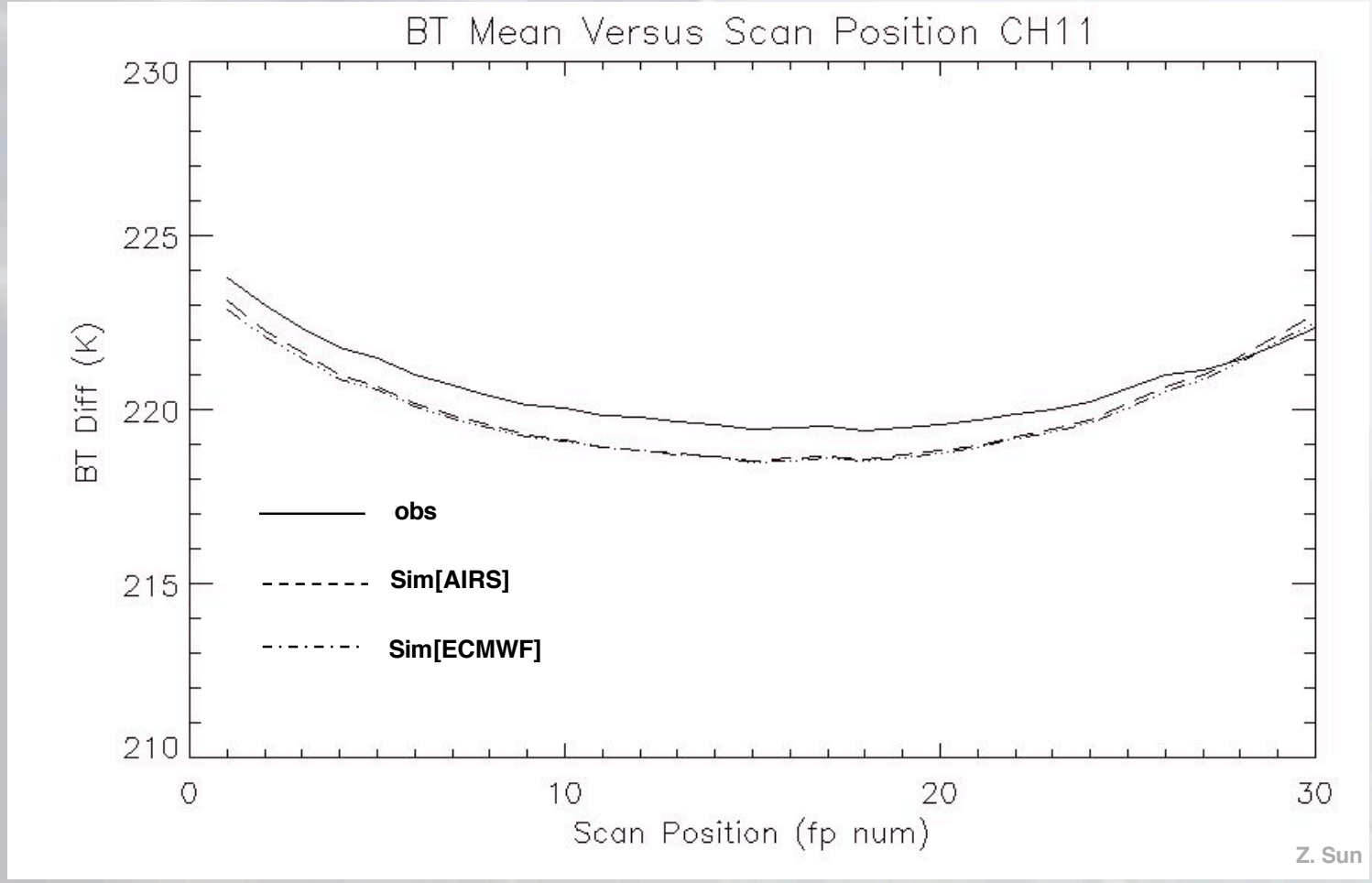
Sim[ECMWF] vs. Sim[AIRS]: Ch. 11



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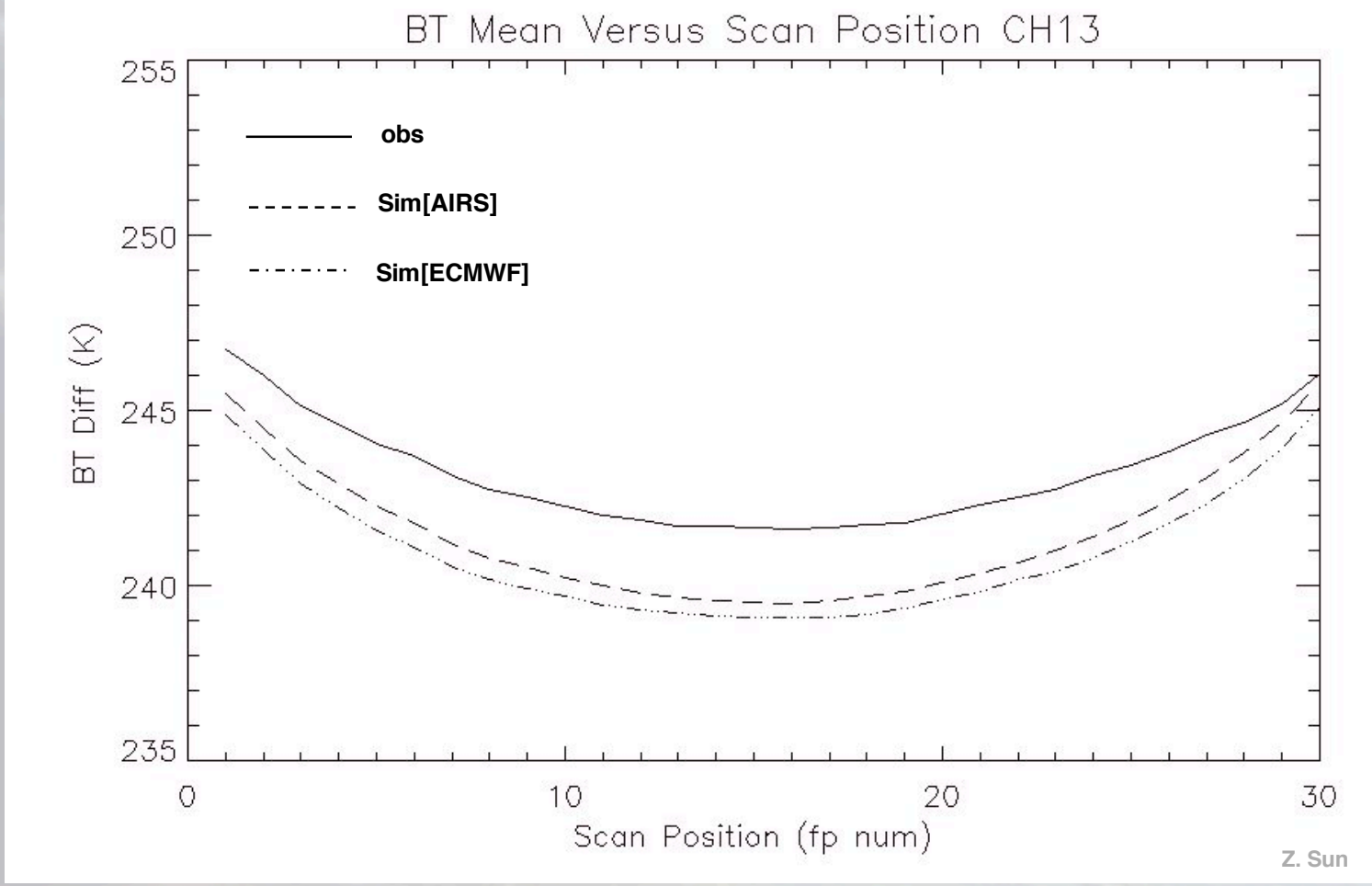
Sim[ECMWF] vs. Sim[AIRS]: Ch. 13



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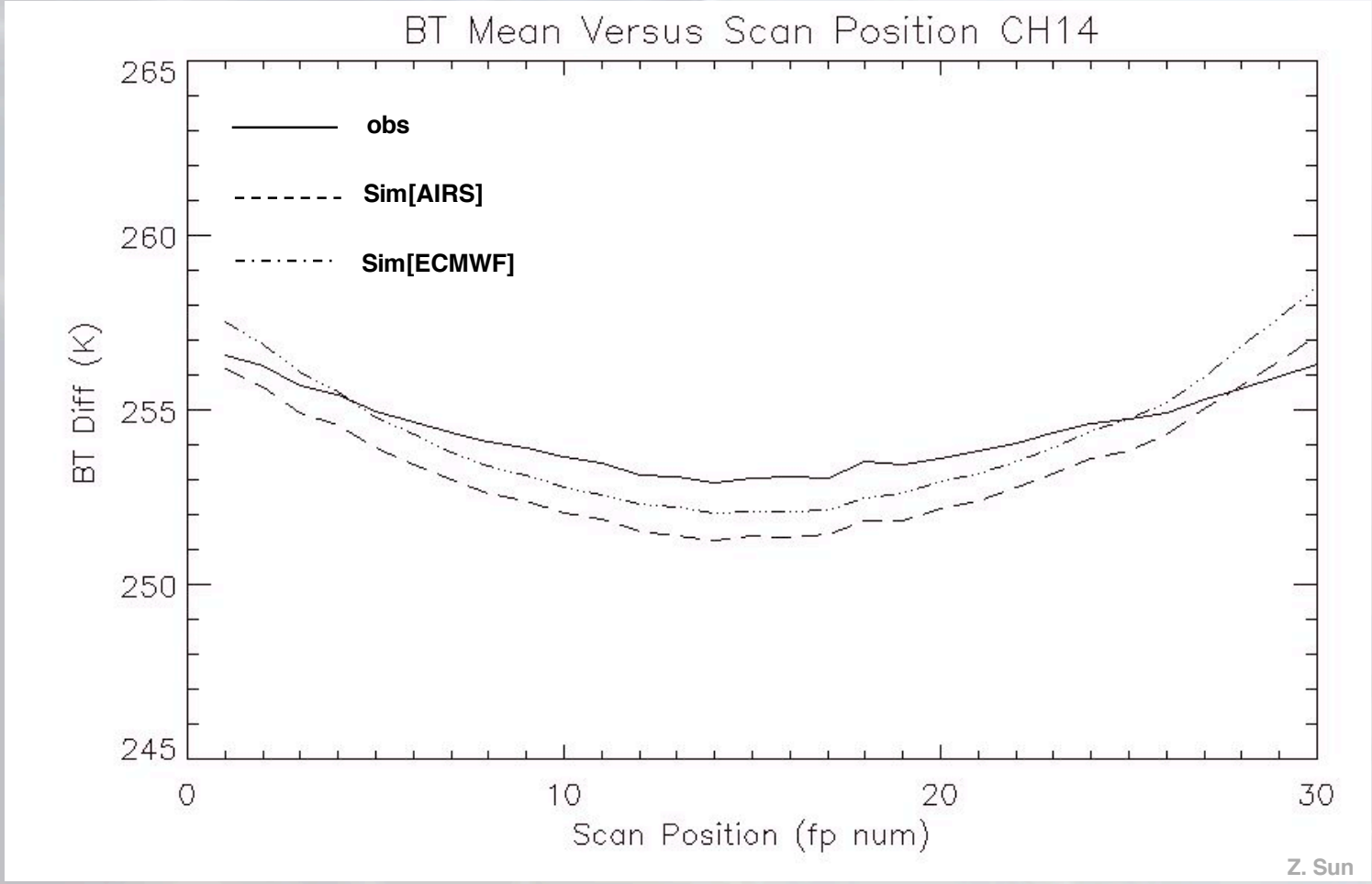
Sim[ECMWF] vs. Sim[AIRS]: Ch. 14



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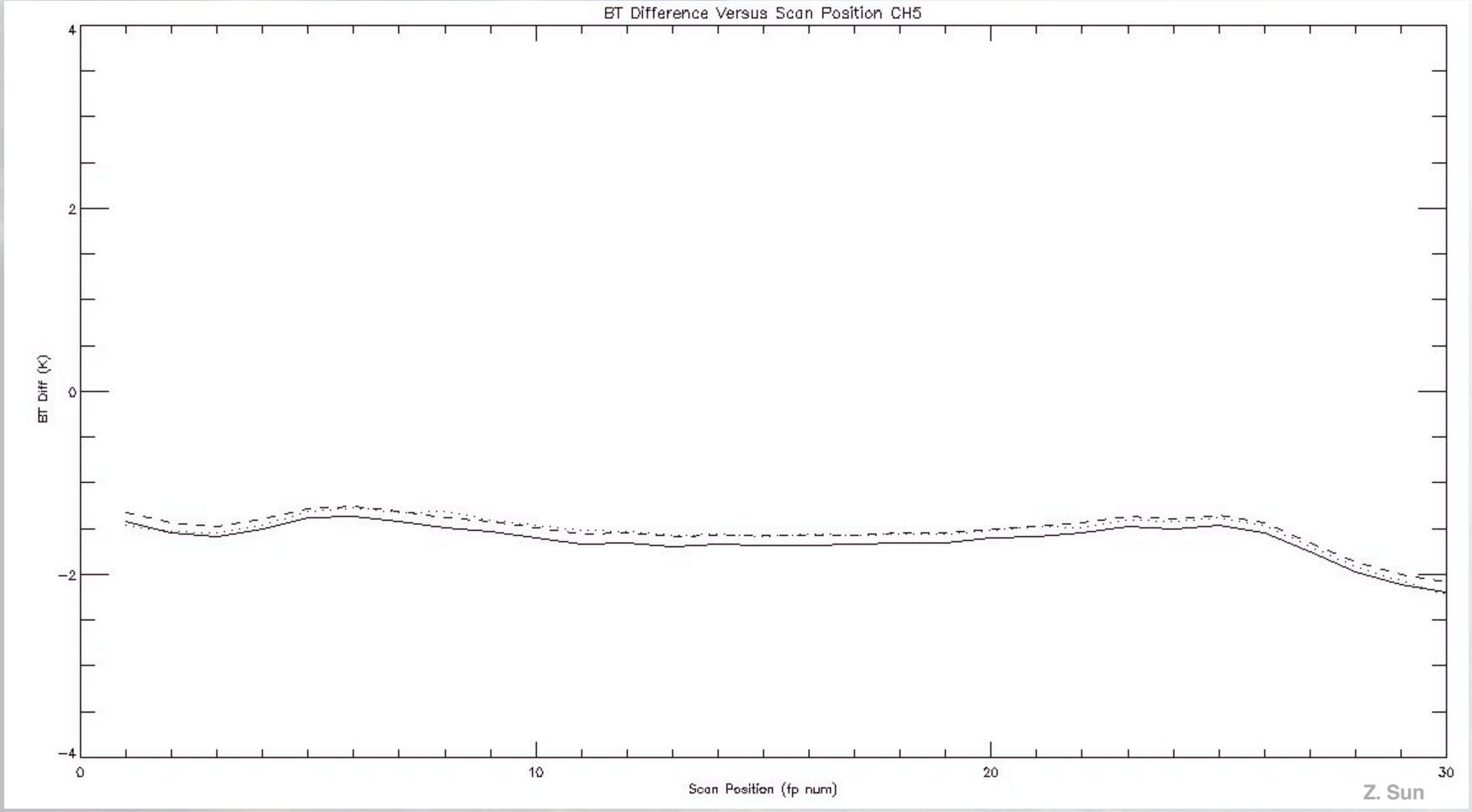
obs-sim[AIRS] vs. obs-sim[ECMWF]

Channel 5



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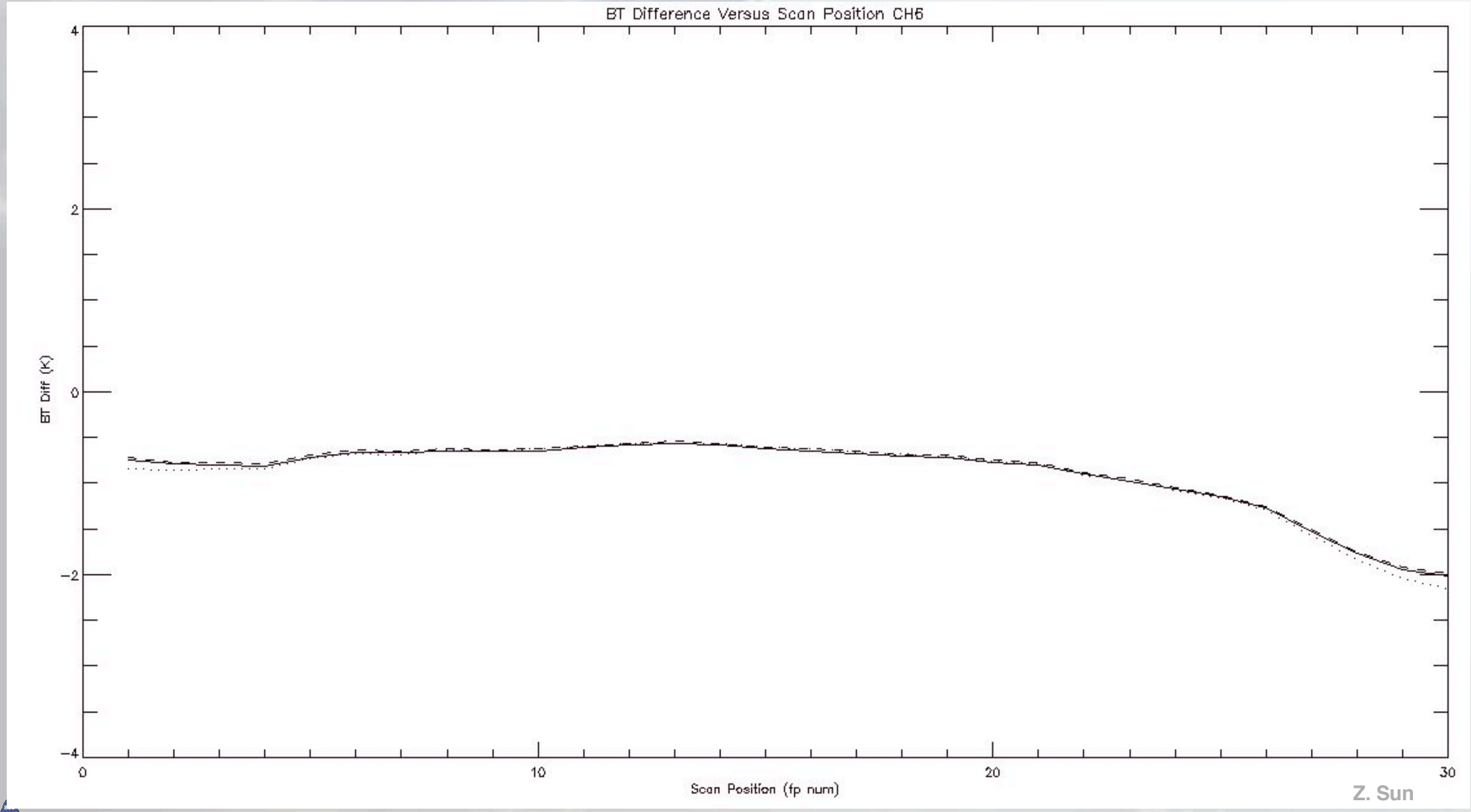
obs-sim[AIRS] vs. obs-sim[ECMWF]

Channel 6



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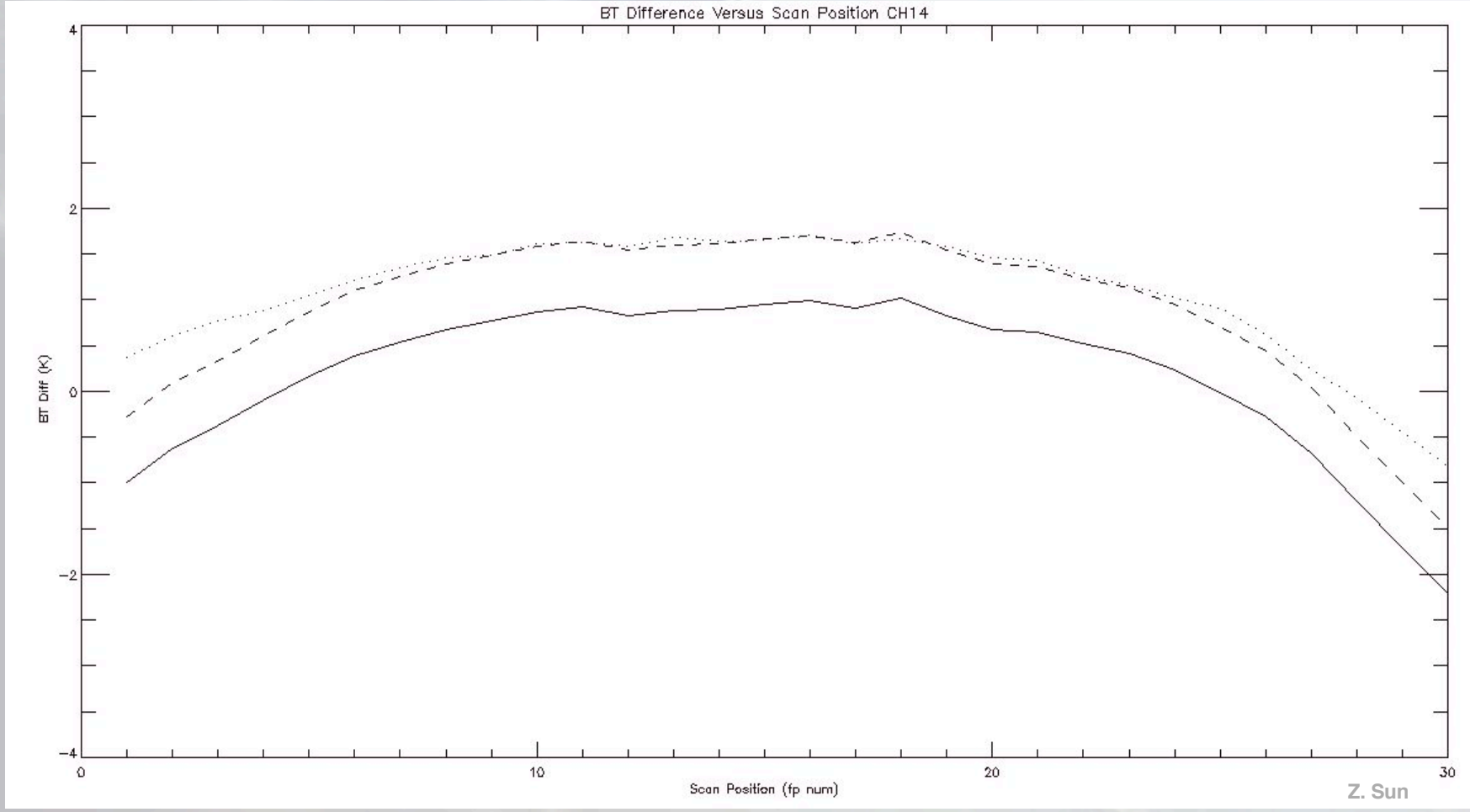
obs-sim[AIRS] vs. obs-sim[ECMWF]

Channel 14



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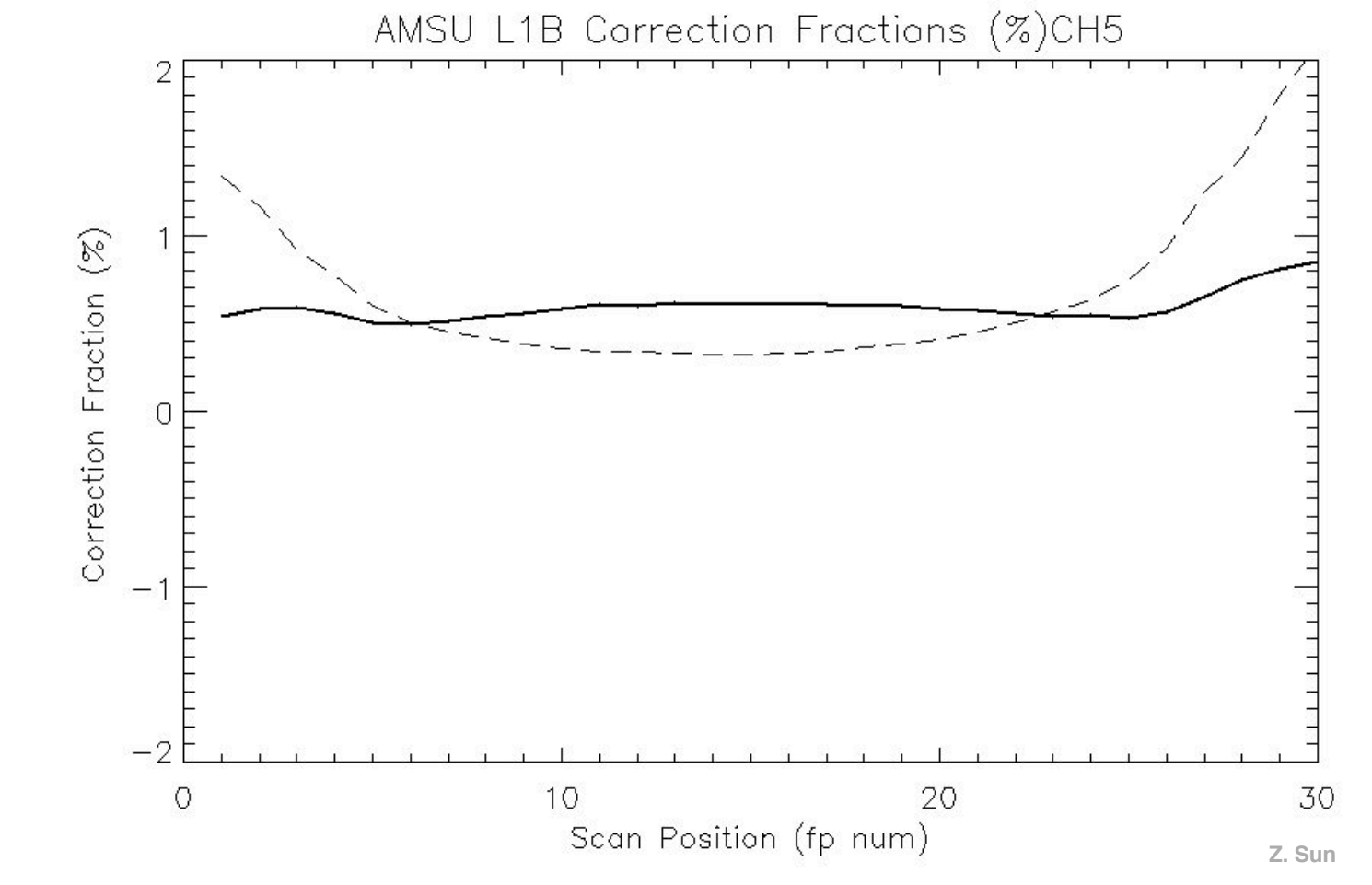
Scan Bias Correction Coefficients

Channel 5



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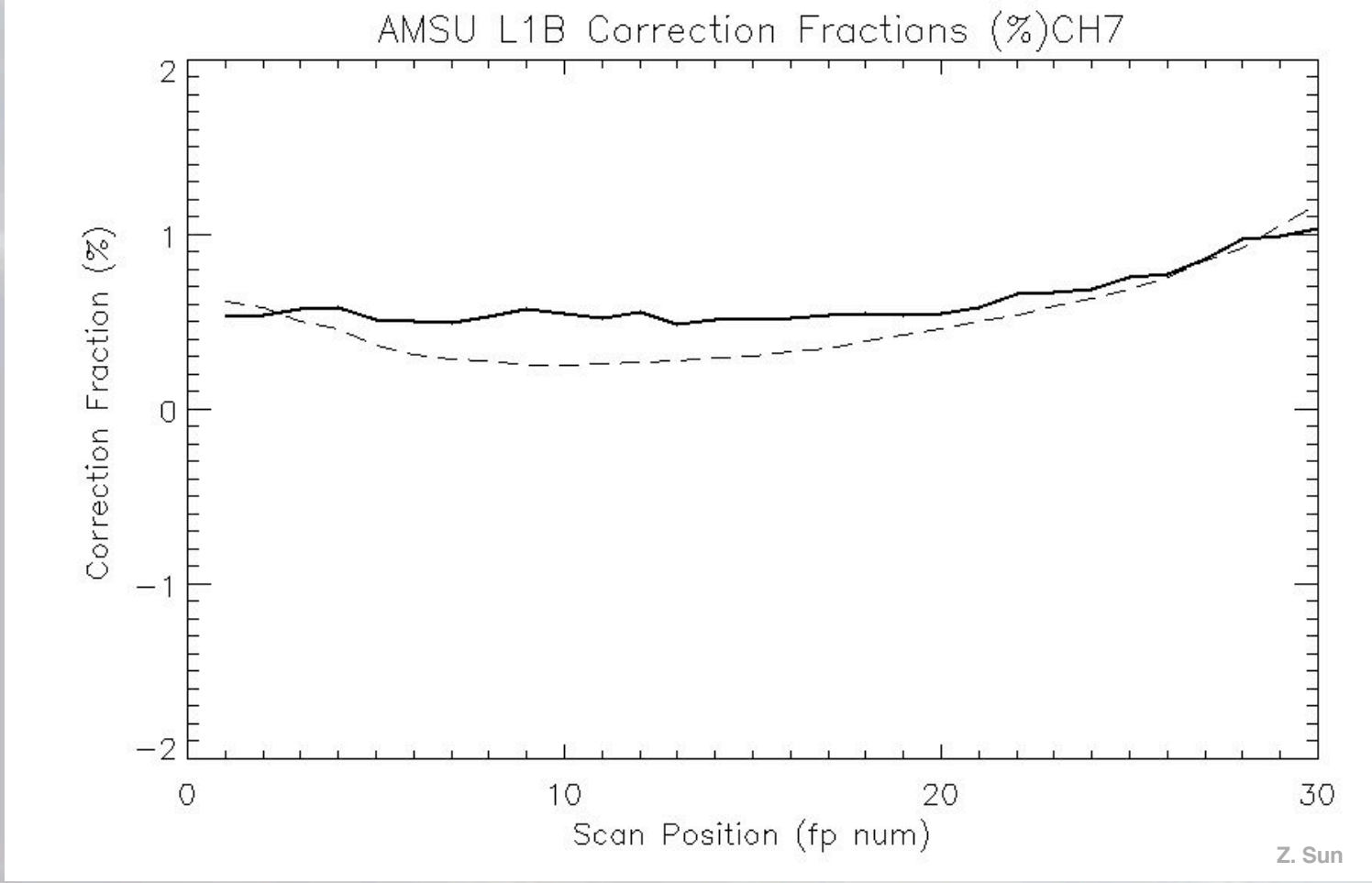
Scan Bias Correction Coefficients

Channel 7



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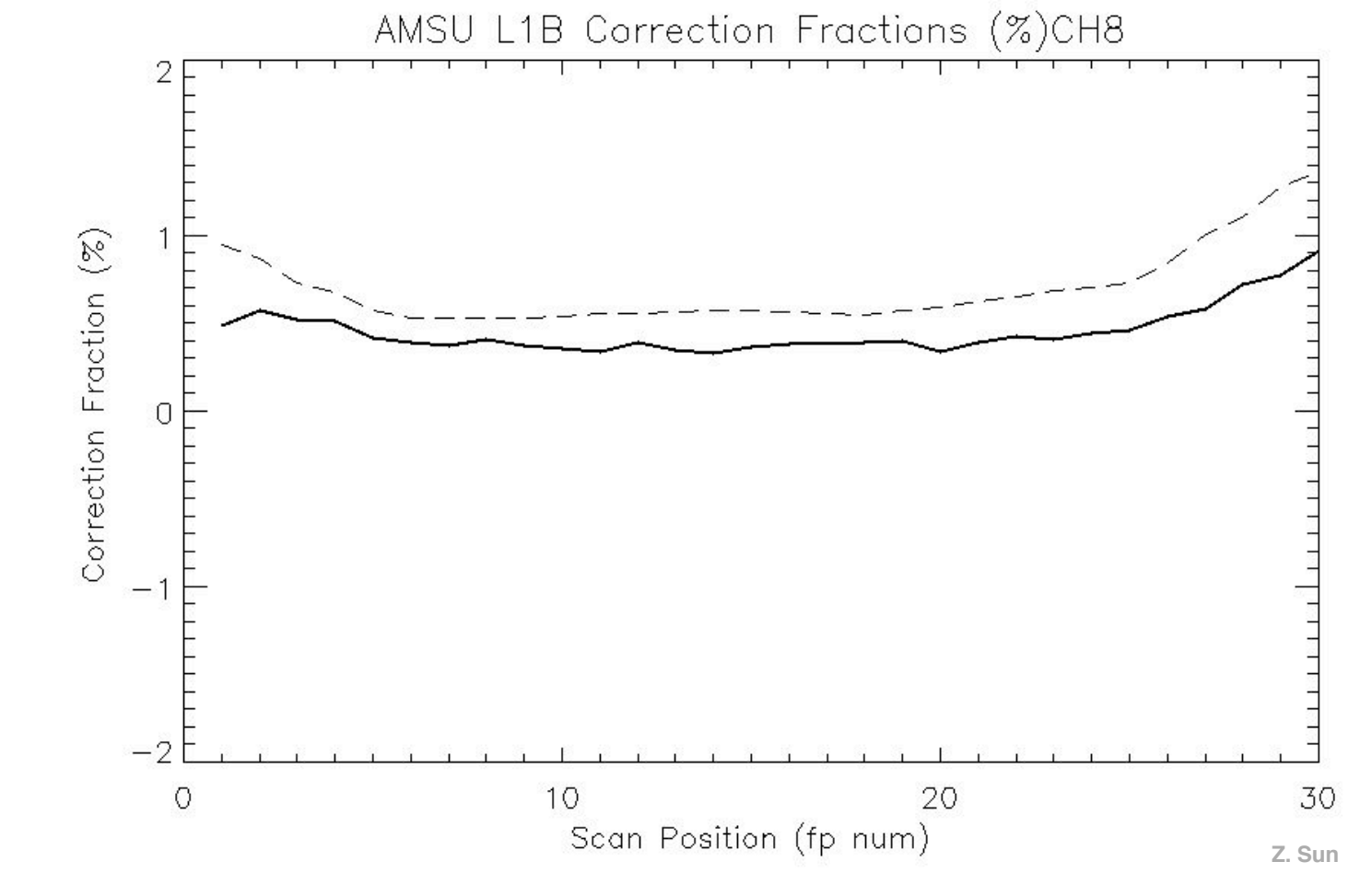
Scan Bias Correction Coefficients

Channel 8



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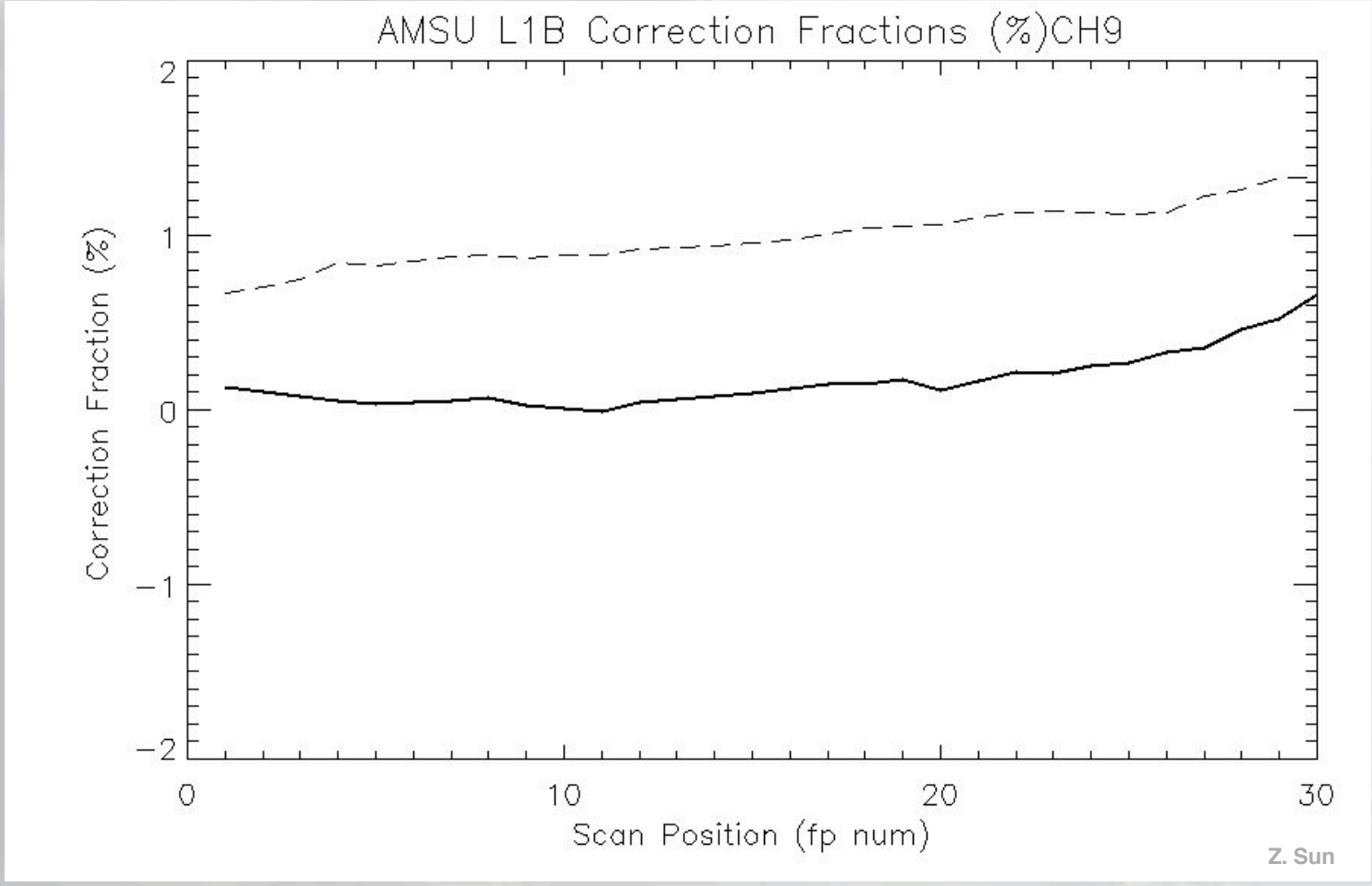
Scan Bias Correction Coefficients

Channel 9



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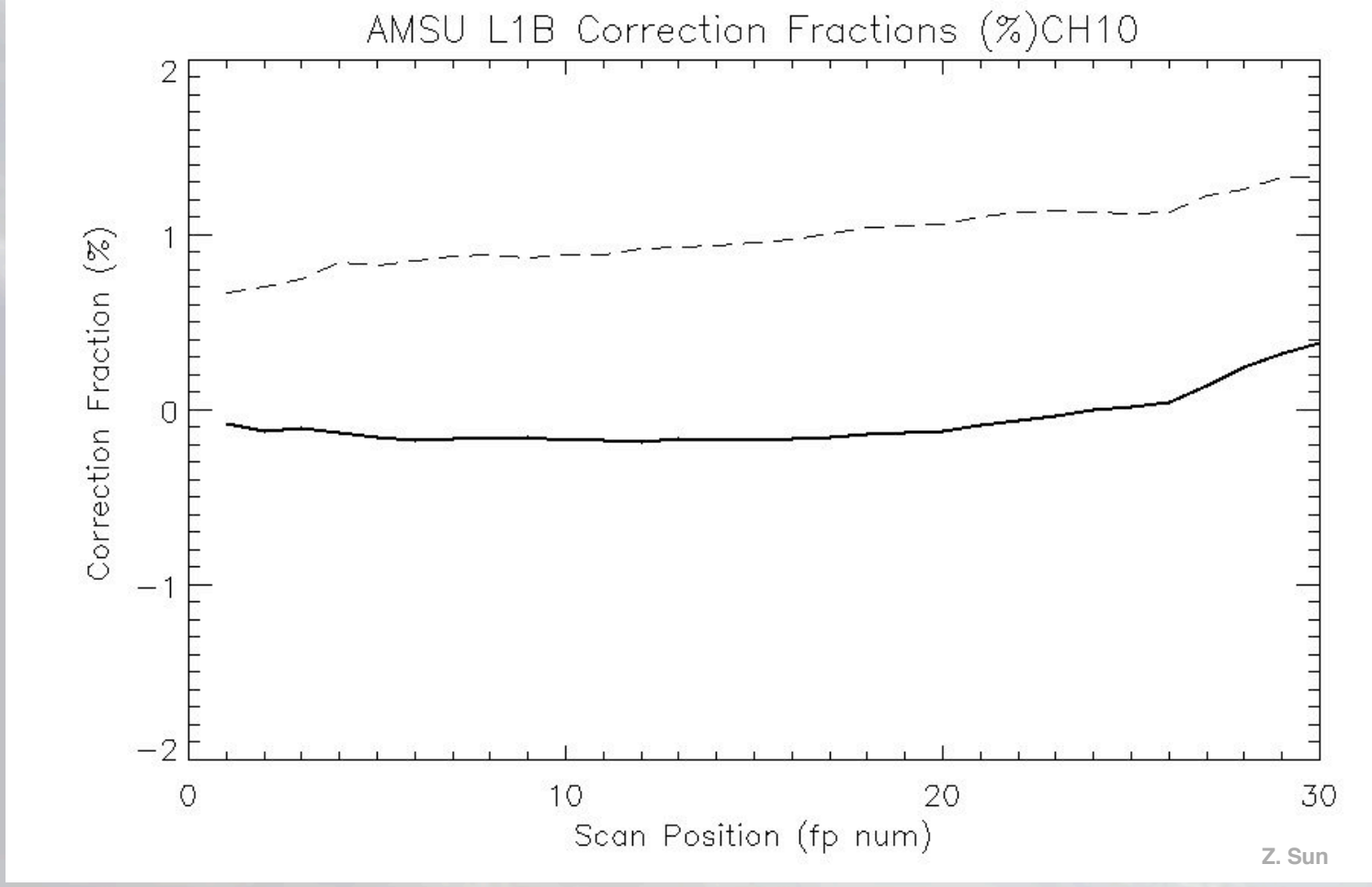
Scan Bias Correction Coefficients

Channel 10



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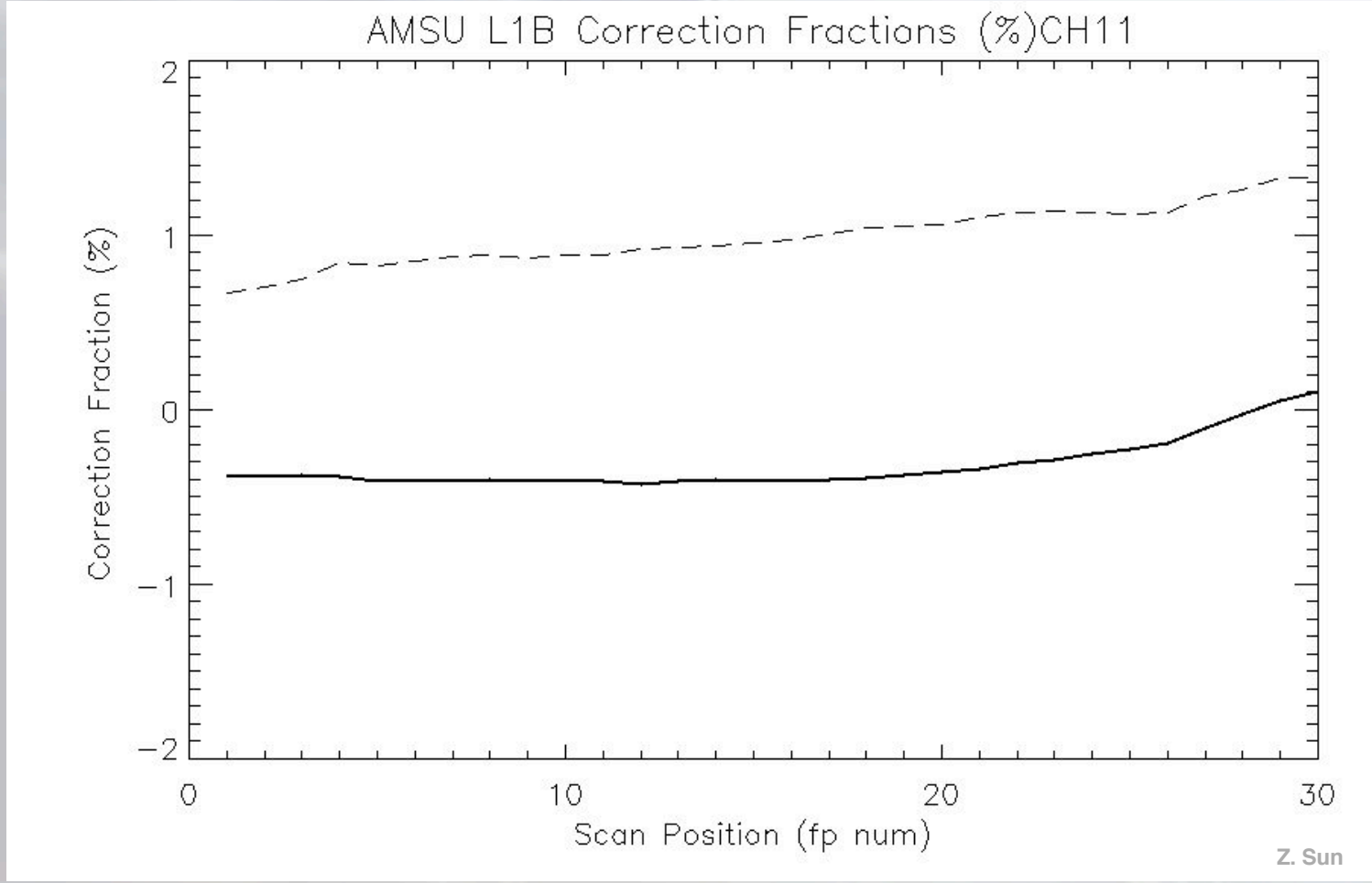
Scan Bias Correction Coefficients

Channel 11



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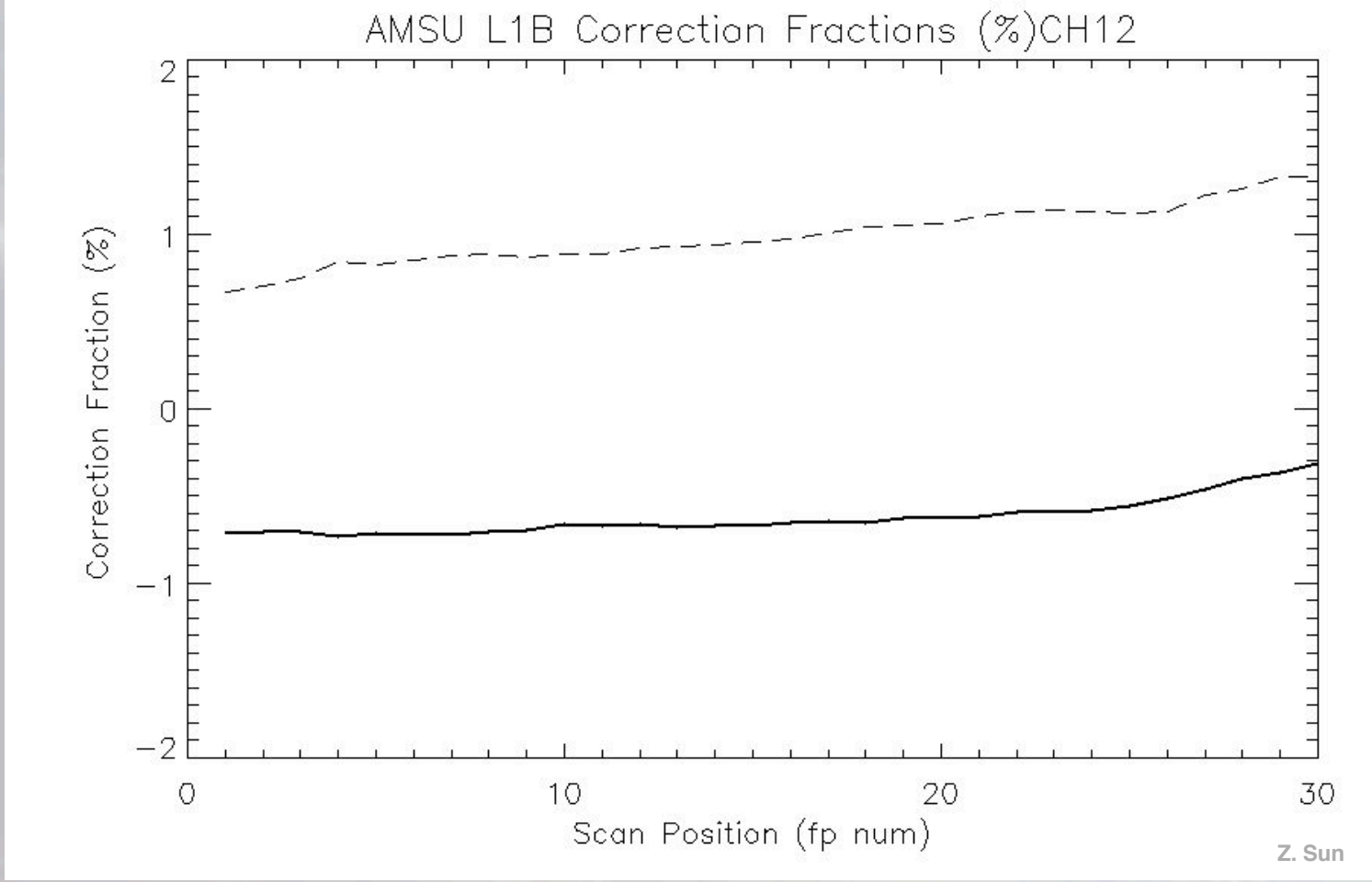
Scan Bias Correction Coefficients

Channel 12



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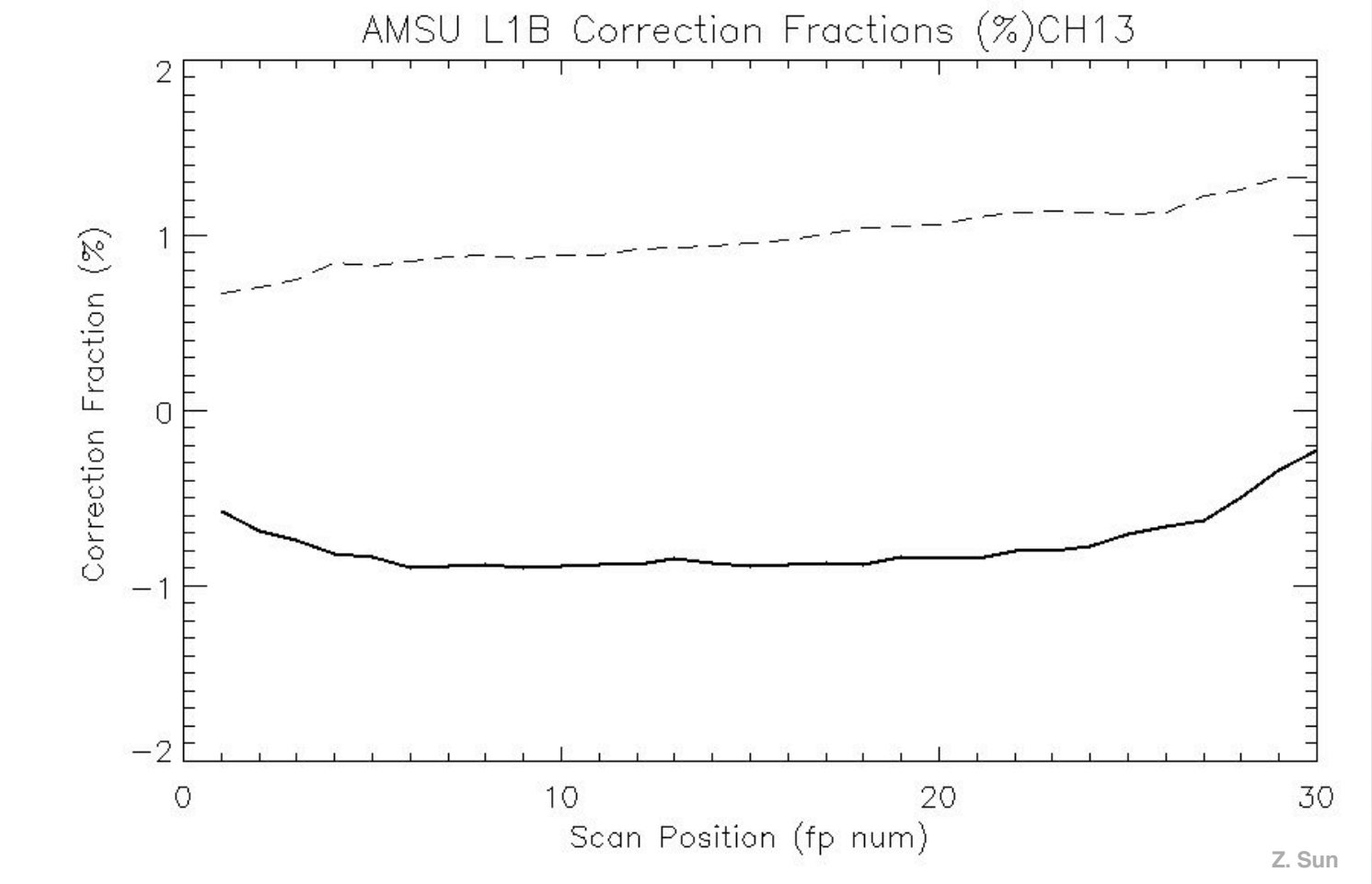
Scan Bias Correction Coefficients

Channel 13



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Scan Bias Correction Coefficients

Channel 14